POWER PLANT ENGINEERING

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Heating System of the General Fire Extinguisher Co.

STEAM IS GENERATED AT HIGH PRESSURE AND USED ONLY FOR HEATING. POWER IS PURCHASED FROM AN OUTSIDE SOURCE. BY CHARLES L. HUBBARD

THE General Fire Extinguisher Co. plant is one of the manufacturing plants of the Grinnell Company and is devoted to the production of equipment for fire protection, including automatic sprinkler heads, dry pipe valves, accelerators, alarm valves and cast-iron pipe fittings and hangers.

The Grinnell Company, in addition to its manufacturing interests, with factories in several cities, carries on an extensive jobbing business in various kinds of material and equipment employed in steam, water, gas and plumbing work, and maintains a complete engineering and construction service for the design and installation of automatic sprinklers, heating and power equipment, and general industrial piping.

This subsidiary plant is of special interest because of its size and completeness, which is unusual in one devoted entirely to heating and process work. Usually, in layouts of this magnitude, the heating system, so far as the boiler and engine room equipment is concerned, is simply an auxiliary of the power plant.

In this case the 300 hp. of Stirling water tube boilers is devoted to the generation of steam used entirely for heating the buildings and in process work. Power is obtained from the Narragansett Electric Light Company. The plant includes three factory buildings, each three stories in height, engine and boiler rooms, labora-

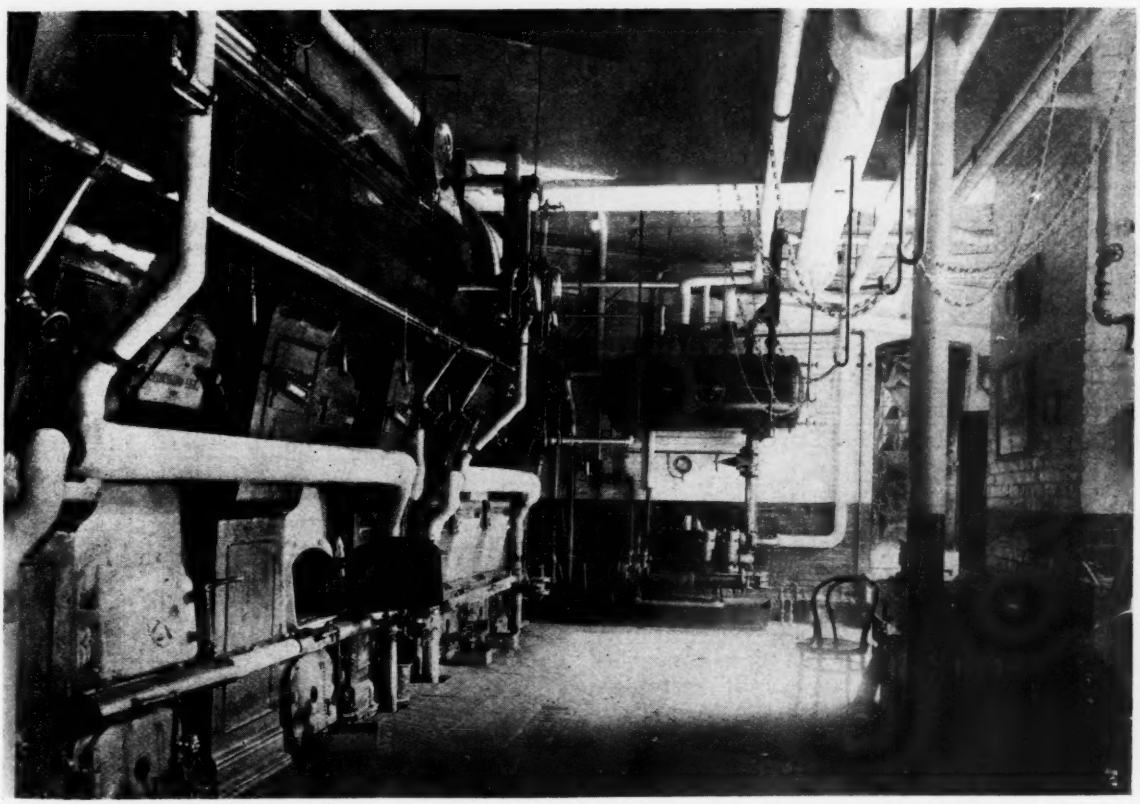


FIG. 1. GENERAL VIEW OF THE BOILER ROOM AT THE PLANT OF THE GENERAL FIRE EXTINGUISHER CO.

tory and administration building, making up a total of approximately 215,000 sq. ft. of floor space.

Boiler Plant

The boiler plant shown in Fig. 1, and the piping in plan and elevation in Fig. 2, consists of three batteries of boilers. Two are made up of two 50-hp. units, and one is a single unit of 100 hp. All five units are equipped for burning fuel oil.

The principle of the oil burning system employed is shown diagrammatically in Fig. 3, which is simpler for purposes of illustration than the actual layout. In operation, oil is drawn from the storage tank by an electrically driven rotary pump and forced through a heater and automatic regulator to the burners. A primary heater at the inlet to the suction pipe in the tank warms the oil so that it will flow readily to the pump, and a secondary heater, beyond the pump, reduces the viscosity to a point low enough for atomization at the burner.

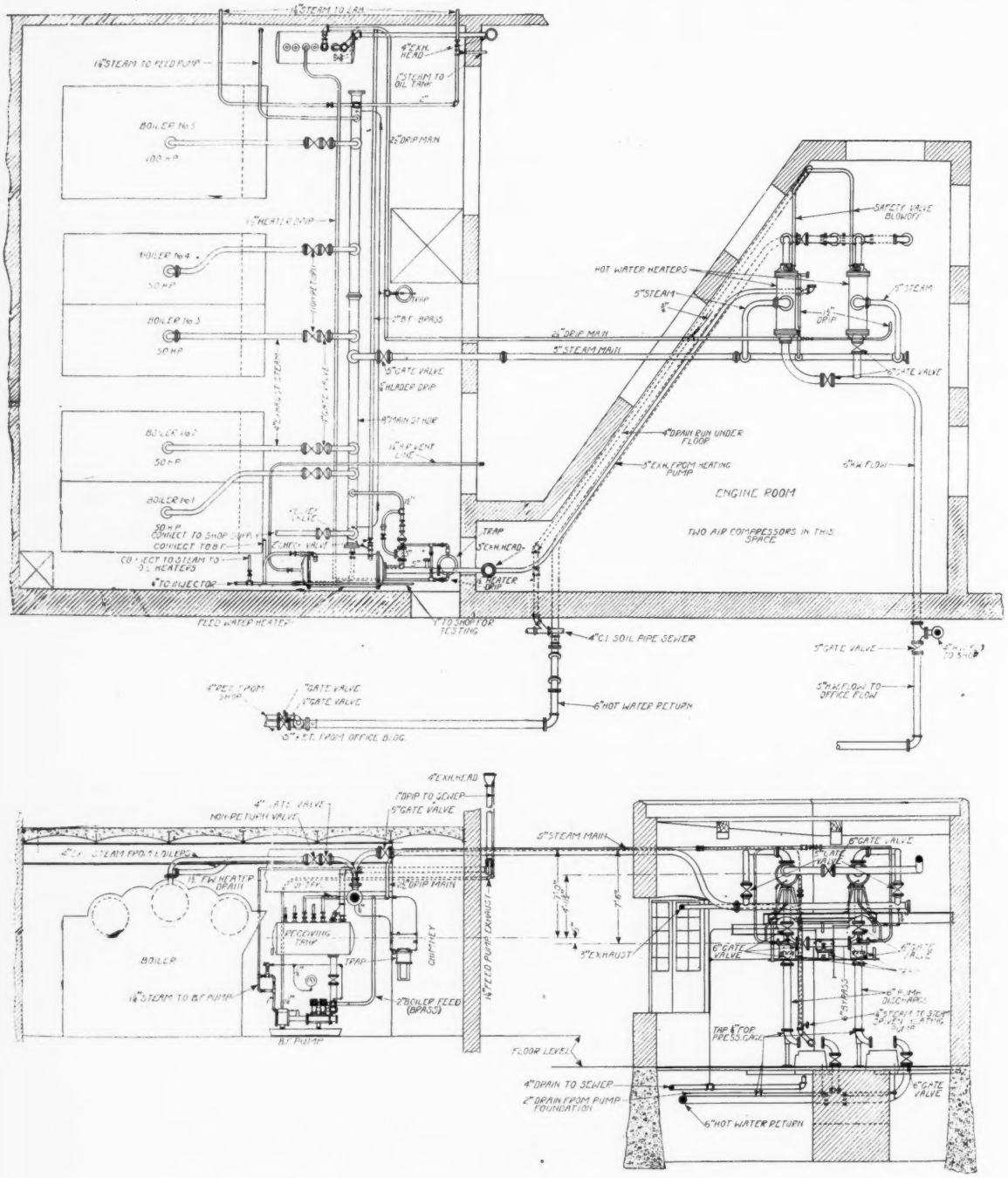


FIG. 2. PLAN AND ELEVATION OF BOILER AND ENGINE ROOMS

The oil pumping system, which is installed in duplicate, consists of a geared rotary pump and centrifugal blower driven by an electric motor. Turbine burners are used, an external view of one of which is shown in Fig. 4, and a cross section of the tip or spraying device, illustrating the principle of operation, in Fig. 5. Air, under pressure, from the blower passing through the turbine "A" causes it to rotate at high velocity. This velocity is transmitted to the cup "B" through the connecting shaft. Oil is fed into the cone cup at the center as shown, and is thrown from the periphery by the action of centrifugal force. In leaving the cup the film is broken up into a fine spray and mixed with the air exhausted from the turbine. Oil supply to the burner is regulated automatically by variations in boiler pressure, which gradually shuts off the flow as the pressure rises. Air supply is controlled by an automatic damper regulator in a manner similar to that employed for a coal fire.

The oil-burning equipment for this plant was designed and installed by the Petroleum Heat & Power Company. Mexican oil, weighing about 8 lb. per gal., is used as fuel, and the daily consumption with two 50-hp. and one 100-hp. unit in service is given in the accompanying table which covers the first half of March for the present year.

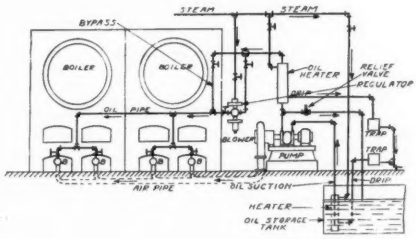


FIG. 3. DIAGRAM OF OIL BURNING SYSTEM

OIL CONSUMPTION FOR THE PERIOD MARCH 1 TO 14, 1922

	Gal.	Lb.
March 1	1,075	8,600
March 2	1,052	8,416
March 3	1,076	8,608
March 4 and March 5	1,037	10,456
March 6	1,050	8,400
March 7	916	7,328
March 8	936	7,488
March 9	1,071	8,568
March 10	771	6,168
March 11 and March 12	1,338	10,704
March 13	904	7,232
March 14	651	5,208

During this period the boilers were operated at approximately their normal rating and were never forced to any extent. The length of day is not given, but it is probably safe to count on 8 hr. as the average working day, although some heat was supplied for a longer period, as indicated by the accompanying chart (Fig. 6) giving the water temperature in the return main for a 24-hr. period (March 1) with an average outside temperature of 34 deg. F. The curve shows that steam was turned into the heating coils shortly after 4 a. m. and that normal conditions were reached at 7 o'clock, and were maintained until 6 p. m., when the temperature fell at a uniform rate until a minimum was reached at midnight. There are no available records as to the rate of evaporation per pound of oil or of the boiler efficiency, but recent tests on similar plants

FIG. 4. TURBINE TYPE OIL BURNER

using the same oil burning equipment show an evaporation of 14 to 15 lb. of water per lb. of oil, and efficiencies of 75 to 80 per cent, with 13.5 to 14 per cent CO_2 in the flue gas.

Ordinarily steam pressure of 70 lb. is carried on the boilers, as that is the pressure required for process work. This steam is used in soda kettles, in pickling and plating vats, for testing and for domestic hot water heating.

The various buildings of the plant are heated by a total of 20,000 sq. ft. of direct radiating surface, not including supply and return mains and connections.

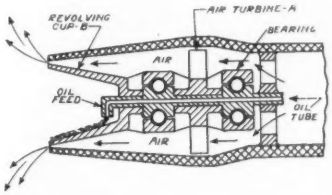


FIG. 5. DETAIL OF ATOMIZING DEVICE ON TIP OF BURNER

Of this surface, from 90 to 95 per cent in the factory buildings is made up of 1¼-in. pipe coils, while the remainder consists of cast-iron sectional radiators.

Hot water heat is employed under forced circulation, the water being heated in tubular heaters by live steam at a reduced pressure of 5 lb. per sq. in.

Pump and Heater Equipment

All pumping equipment as shown in Fig. 7 is located in the "engine room," a one-story building adjacent to the boiler house. Pipe connections between the pumps and heaters are shown in Figs. 2 and 8. There are two duplicate heaters, each capable of doing the entire work,

and so piped for both steam and water that they may be used singly or together. These heaters are of the "water tube" type, each containing 130 sq. ft. of brass tube surface, and designed to carry a working pressure of 100 lb. The drawings show the heaters piped for taking steam at boiler pressure, but arrangements have since been made for reducing it when desired. Heaters designed on the water-tube principle have a higher efficiency, owing to the greater velocity of the water over the heating surfaces. It is interesting in the present

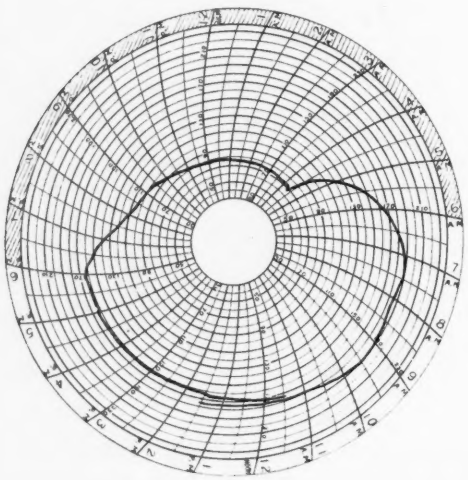


FIG. 6. CHART FROM RECORDING THERMOMETER IN RETURN LINE FROM HEATING SYSTEM SHOWING DAILY TEMPERATURE VARIATION

case to check up the value of the coefficient of heat transmission in B.t.u. per sq. ft. of tube surface per hour per degree mean difference in temperature between the steam and water, under the conditions of actual

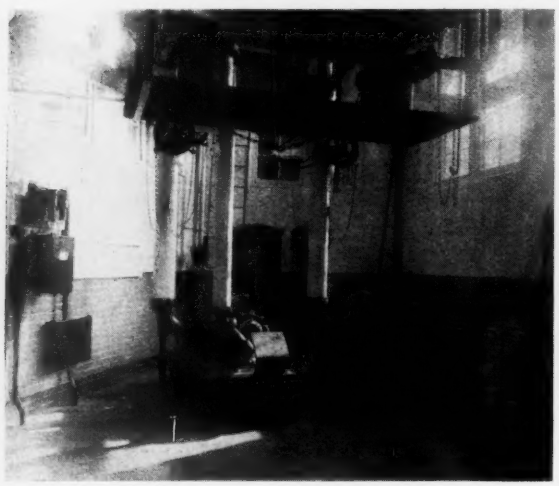
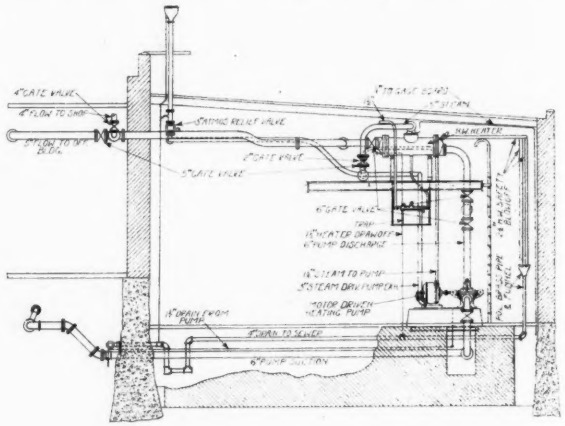


FIG. 7. PUMPING EQUIPMENT CONSISTING OF ONE MOTOR AND ONE TURBINE DRIVEN UNIT

service. Tests were run March 22, 23 and 24 of the present year, with the following average results:

Water circulated per min	400 gal.
Average temperature in flow main	190 deg.
Average temperature in return main	170 deg.
Steam pressure in heater	5 lb.

Here we have a drop in water temperature of 190 — 170 = 20 deg. and an average water temperature of (190 + 170) ÷ 2 = 180 deg. As the temperature of steam at 5 lb. gage is 228 deg. F., the difference between



FIR. 8. SECTIONAL ELEVATION OF PUMP ROOM

steam temperature and average temperature of water is 228 — 180 = 48 deg.

Weight of water circulated per hour is 400 × 8.3 × 60 = 199,200 lb.; which, with a temperature drop of 20 deg., will give up 199,200 × 20 = 3,984,000 B.t.u. per hr. Heat furnished per sq. ft. of tube surface per hour = 3,984,000 ÷ 130 = 30,640 B.t.u., or 30,640 ÷ 48 = 638 B.t.u. per deg., which is the value of the coefficient of heat transmission.

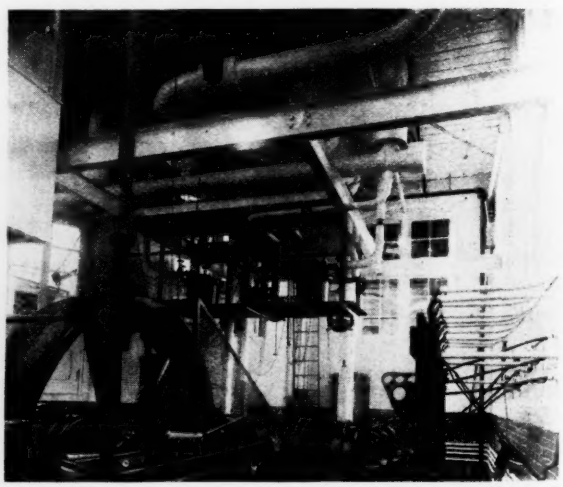


FIG. 9. VIEW OF PUMP ROOM SHOWING AIR COMPRESSOR, HOT WATER HEATERS, TRAPS, PIPING AND VALVE OPERATING CHAINS

The general form of one of the heaters is best shown in Fig. 8, which also illustrates the pipe connections and method of support. The shell and heads are of cast iron. Water from the pump is delivered at one end near

the bottom and discharged from the other end near the top. Steam is admitted at the top of the shell, and the condensation drained to a trap, directly below it, which discharged into a receiving tank in the boiler room, from which it is pumped back to the boilers. There is also provided a safety or relief valve, and a drain connection, both of which are piped to the sewer.

There are two pumping units, one motor driven and the other turbine driven. The first of these consists of a Gould's centrifugal pump rated at 550 gal. per min. at 1740 r.p.m., against a 60-ft. head. The motor is a General Electric induction, 3-phase, 60-cycle, rated at 20 hp. at 1760 r.p.m. The turbine unit consists of a De Laval centrifugal pump rated at 450 gal. per min. at a speed of 2400 r.p.m., against a head of 35 to 40 ft. The turbine has a normal speed of 2400 r.p.m. at 100 lb. steam pressure and runs at an actual speed of 2000 r.p.m. with 75 lb. pressure.

The test previously referred to was made with this pumping unit running at the lower speed.

Either pump will handle the entire system alone, although it taxes the smaller unit to the limit.

Tests for frictional head in the mains show an average of about 8 lb. or 20 ft. with the smaller pump moving about 400 gal. per min. and 22 lb. or 55 ft. with the larger pump operated at full speed and delivering approximately 550 gal. The static head on the system due to the height of the expansion tank is about 46 ft.

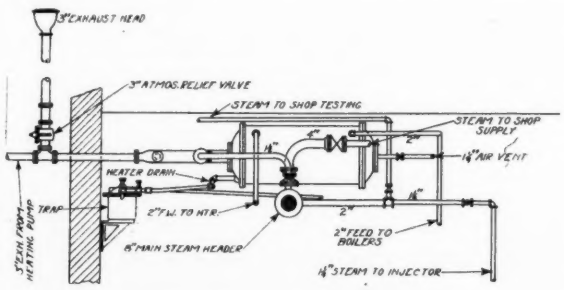


FIG. 10. FEED WATER HEATER AND PIPING

Engine Room Equipment

While an engine room is referred to, and shown on the plans, no engine appears. This room formerly held a 125-hp. Corliss engine, with a belt drive to the main shaft in the factory building, but the unit was discarded some years ago and electric drive substituted, power being obtained from an outside source as previously noted. The space formerly occupied by the engine is now taken by two motor-driven air compressors, one of which is illustrated in Fig. 9, which also shows the hot water heaters and traps described in connection with the heating system. Attention is also called to the chain operated valves and the belt guard on the compressor unit.

Piping System

The length of the circuit supplying the radiation in the factory buildings is approximately 800 ft., and for the Administration buildings 1300 ft. All pipe lines under full boiler pressure are full weight mild steel, made up with extra heavy valves and fittings. Sizes 4-in. and over have lap joints and steel flanges. All other lines of piping, except the boiler feed, are of standard steel with standard weight fittings.

Connections between the feed pump and boilers are of brass, iron pipe size, made up with brass fittings.

All condensation from the main water heaters, feedwater heater, drainage from steam lines and other sources where the water is free from oil or other impurities is trapped to a receiver located in the boiler room and returned to the boilers by a Blake-Knowles 6 by 4 by 6-in. pot-valve outside-packed pump. The exhaust from the feed pump and the vent from the receiving tank connect with an outbound riser provided with an exhaust head as shown in Fig. 2. The exhaust from the pump turbine, being free from oil, is piped to a 200-hp. National feed water heater, which also has a live steam connection through a pressure reducing valve. The exhaust pipe has an outboard connection provided with a back pressure or relief valve, as shown in Fig. 10. The general arrangement of the various pipe lines is indicated by notes on the drawings and does not require further description.

Coal Steaming

Costs, Steam Consumption and Mechanical Details. By A. W. Binns

COAL steaming becomes necessary when the coal cannot be unloaded without great difficulty. With heavily frozen coal it would take four men at least a day to unload one car of coal. It is our practice to steam the coal in order to thaw the ice and allow the coal to flow freely. To this end a steaming pipe is installed as shown in Fig. 1 and the coal is steamed by thrusting 7-ft. lengths of pipe into the car, the steam flowing through the while. It is easily possible to bury the pipe into the center of the car in this manner.

Details of construction are shown in Fig. 8. We have found this construction quite successful.

Details of steam used, labor cost and time follow.

Classes of Frozen Coal

Frozen coal may be divided into three classes:

1. Slightly frozen—cars with the pockets frozen and a little frozen coal on the sides. Two hoses in this for about one-half hour is all that is needed.

2. Medium frozen coal—cars in which the bottom and sides are frozen, but which is not frozen throughout. Two hoses for two hours are needed.

3. Badly frozen coal—where the coal is frozen solid throughout the whole car and resembles concrete. We steam these cars overnight with valves about one-fourth way open, or with two hoses for four hours.

Therefore:

Lightly frozen, 2 hoses	½ hr.
Medium frozen, 2 hoses	2 hr.
Badly frozen, 2 hoses	4 hr.

Annual Steaming Period

We steam coal intermittently throughout December, January and February and occasionally before or after these months. For two months we have about half and half of heavy and medium freezing and for one month light freezing; these conditions vary greatly, of course, with the severity of the winter. We handle about 13 cars per day, or 18,000 T. per month.

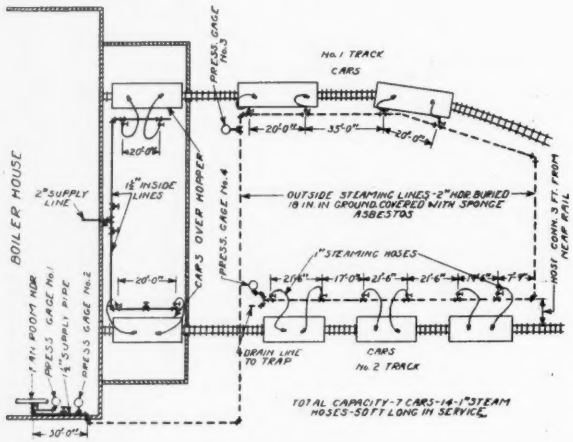


FIG. 1. GENERAL PLAN AND LAYOUT FOR COAL-STEAMING LINES

Assuming, therefore, a winter of 90 days, 13 cars per day, and steaming rates as above, we have for use of steam hoses:

Light freezing	½ × 30 × 13 =	195 hose hours
Medium freezing	2 × 30 × 13 =	780 hose hours
Heavy freezing	4 × 30 × 13 =	1560 hose hours
Hose hours per season.....		2535

Steam Flow by Friction Method

The layout in the steam yard appears in Fig. 1, with gages connected as shown. Length of pipe between pressure gages 1 and 2, Fig. 1, used in calculation by friction

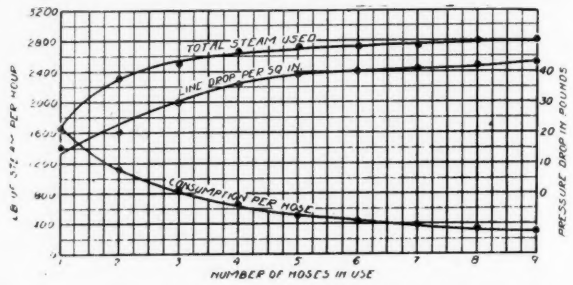

TOTAL STEAM USED
LINE DROP PER SQ IN.
CONSUMPTION PER HOSE
LBS OF STEAM PER HOUR
PRESSURE DROP IN POUNDS
NUMBER OF HOSES IN USE

FIG. 2. RELATION OF STEAM CONSUMPTION TO NUMBER OF HOSES IN SERVICE

method—1½-in. standard lap welded was estimated on the following basis:

Length of straight pipe.....	45 ft.
4 ells at 40 dia. each.....	20 ft.
Entrance to pipe at header 60 dia.....	8 ft.
3 globe valves—60 dia. each.....	22 ft.
2 unions—20 dia. each.....	10 ft.
	105 ft.

Allow 25 per cent extra for age of pipe (1¼ yr.) and consider length 125 ft.

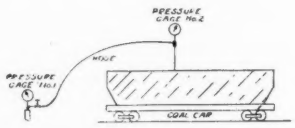


FIG. 9. METHOD OF MEASURING DROP THROUGH HOSE WHILE STEAMING CARLOAD OF COAL

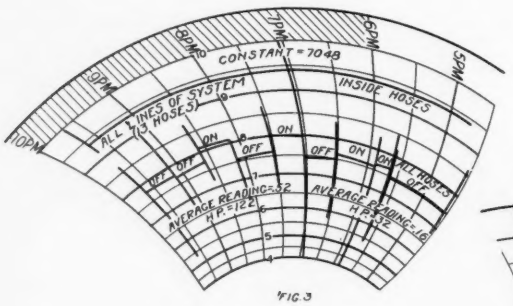


FIG. 3

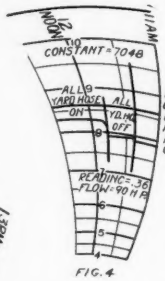


FIG. 4

NOTE—THE LOAD WAS HELD CONSTANT AND THE STEAM USED IN THE HOSES IS REPRESENTED BY THE INCREASE IN PEN READING ON THE CHART.

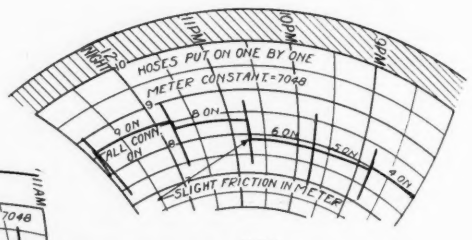


FIG. 5

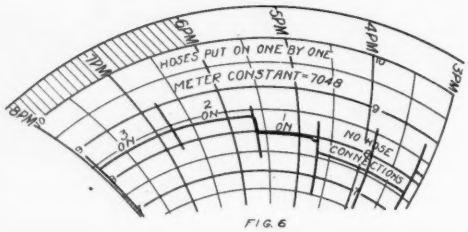


FIG. 6

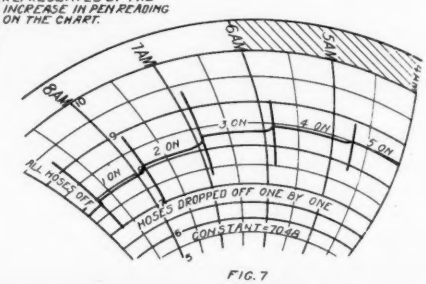


FIG. 7

FIG. 3. RECORD OF STEAM USED BY INSIDE LINES AND TOTAL CONSUMPTION OF ALL LINES. FIG. 4. STEAM USED BY YARD LINES. FIGS. 5, 6 AND 7. VARIATION OF STEAM FLOW WITH SINGLE HOSE ADDED OR REMOVED FROM LINE

Observations of pressures with varying numbers of hoses turned on were taken as follows:

No. hose in use	Gage No. 1, lb. per sq. in.	Gage No. 2, lb. per sq. in.	Pressure drop, lb.	Gage No. 3, lb. per sq. in.	Gage No. 4, lb. per sq. in.
None	150	150	..	..	..
1	150	135	15	101	..
2	150	125	20	76	..
3	150	120	30	60	..
4	152	116	36	52	..
5	147	108	39	45	..
6	140	103	37	39	..
7	144	102	42	36	..
8	146	105	41	34	..
9	153	110	43	33	23
8	145	107	38	36	28
7	140	102	38	36	35
6	145	107	38	40	35
5	145	111	34	48	45
4	150	117	33	46	55
3	150	134	16	70	65
2	152	133	15	93	80
1	150	144	6	..	..
None	150	150	..	..	..

No. hose Open	Corrected pressure drop, gage	T otal flow lb. per hour	Flow per hose lb. per hour
1	15	1626	1626
2	20	2340	1146
3	30	2580	860
4	36	2670	668
5	39	2718	543
6	40	2725	454
7	41	2750	393
8	42	2800	350
9	43	2820	313

From the above, total flow with nine lines on = 2820 lb. per hr. = 94 hp. Curve, Fig. 2, shows graphically these relations.

Values were computed by formula,

$$W = \sqrt{[w\,(P^1 - P_2)\,d \div L]}$$

Where W = lb. per minute discharged
P_1 and P_2 = initial and final pressure
d = diameter of pipe in inches
L = length of pipe in feet.
w = density = 0.3666.

Comparison with nine hose in use:

Total flow by friction method = 94.0 hp.
Total flow by meter = 85.0 hp.

Theoretical Discharge Into Atmosphere

Referring to Fig. 9, a test was made of the discharge of one hose into the atmosphere and into the coal at various depths. The results are:

Ft. deep in coal	Gage No. 1 lb. abs.	Gage No. 2 lb. abs.
1	95	50
3	95	50
6	95	50
7	95	50
to atmosphere	90	37

Using Napier's formula the weight of steam flow per hour, $W = \frac{Pa}{70} \times 3600 = \frac{37 \times 0.7854 \times 3600}{70} = 1495.28$ or practically 1500 lb. per hr.

Steam Used As Shown by Flow Meter

Meter reading — Meter constant

Outside lines
9 hose on line $0.36 \times 7048 = 2537$ lb. per hr. = 85 hp.
Steam per hose $2537 \div 9 = 282$ lb. per hr.
4 hose on line $0.125 \times 7048 = 881$ lb. per hr. = 29 hp.
Steam per hose $881 \div 4 = 220$ lb. per hr.
All 13 steam connections wide open $0.52 \times 7048 = 3660$ lb. per hr., $3660 \div 30 = 122$ hp.
= Total consumption 13 hoses.

The consumption per hose will, of course, vary greatly with the number of hoses in service, but should average up over a period of time. Now assuming an average flow value of 280 lb. per hr. per hose, the steam used per season will be 2538 (hose hours) × 280 lb. = 710,000 lb. steam in three months, or 3 × 18,000 (tons of coal used per month) = 54,000 T. coal steamed.

From this we calculate that the pounds of steam used per ton of coal = 710,000 ÷ 54,000 = 13.15.

Standby Consumption

At night and at other times when the hoses are not in use, it is necessary to crack the valves and allow a small amount of steam to escape in order to prevent

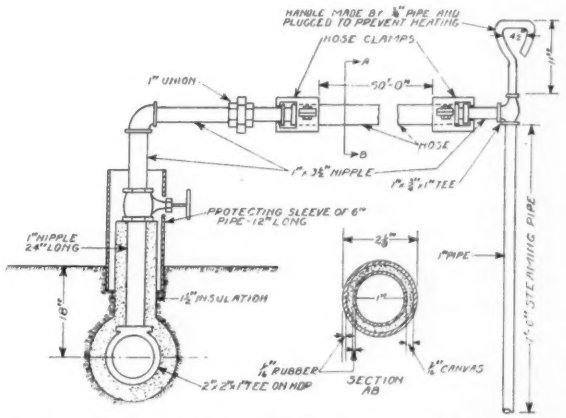


FIG. 8. DETAILS OF HOSE, CONNECTION AND STEAMING PIPE USED

freezing. Condensing tests were run on this line as follows:

Time	Wt. water before	Wt. water after	Wt. steam condensing	Lb. per hr.
2 min.	24 lb.	26 lb.	2 lb.	60 lb.
2 min.	25 lb.	27 lb.	2 lb.	60 lb.
2 min.	20 lb. 8 oz.	22 lb.	1 lb. 8 oz.	45 lb.
				165

$165 \div 3 = 55$ lb. per hour average.

The hose stand by on an average of 12 hr. per day, or in a 90-day season: $90 \times 12 \times 13 \times 55 = 772{,}200$ lb. At 54,000 T. per season the standby steam consumption per ton of coal = 14.3 lb.

To this must be added condensation loss in line and radiation. No attempt is made to include these.

COST

COST due to steam, assuming the cost of steam at 40

cents per 1000 lb. $= \frac{13.15 \text{ lb.}}{1000} \times 40 = 0.526$ cents.

Cost due to standby loss $= \frac{14.3}{1000} \times 40 = 0.572$ cents.

Two men are employed who spend their entire time steaming coal. Cost of labor of these two men at 30 cents an hour, 9 hr. a day for 90 days, amounts to 48,600 cents.

Cost per ton $= 48{,}600 \div 54{,}000 = 0.900$ cents per ton.

On an average we use three hoses per year, and at $60 per 50-ft. length, equals $180. Connections must be made and removed at the beginning and end of the season at a cost of $50; total maintenance $230. Cost of maintenance per ton of coal $= 23{,}000 \div 54{,}000 = 0.426$ cents.

Total Cost:	
Steam	0.5260
Standby	0.572
Labor	0.900
Maintenance	0.4260
	2.424 cents per ton

To these costs must be added the extra work of the dinkey spotting and moving cars and considerable overtime occasioned by waiting for coal to thaw out and also loss of time due to breaking with sledge hammers the lumps of coal which have not been thoroughly thawed.

A cost of 2.5 cents per ton would probably be very near the correct figure.

Scraper Ash Conveyor

BY HUGH T. REID

IT CAN truthfully be said that the handling of ashes in the boiler plant is one of the most trying and difficult problems in the routine of the average plant where the quantity of ashes produced is 10 T. or more per day. Although the relative proportion of ashes by weight compared with the coal handled that produces the ashes is very small, the wear, grinding and corrosive action is infinitely greater. This means that all parts of the conveyor must be carefully planned and designed, and that duplicates must be carried in stock at all times to guard against break-downs. Needless to say, all these things add to the first and maintenance cost of the conveyor, and present at times, a problem that is quite serious.

The plant with which the writer is connected, after going through a series of such occurrences, having in-

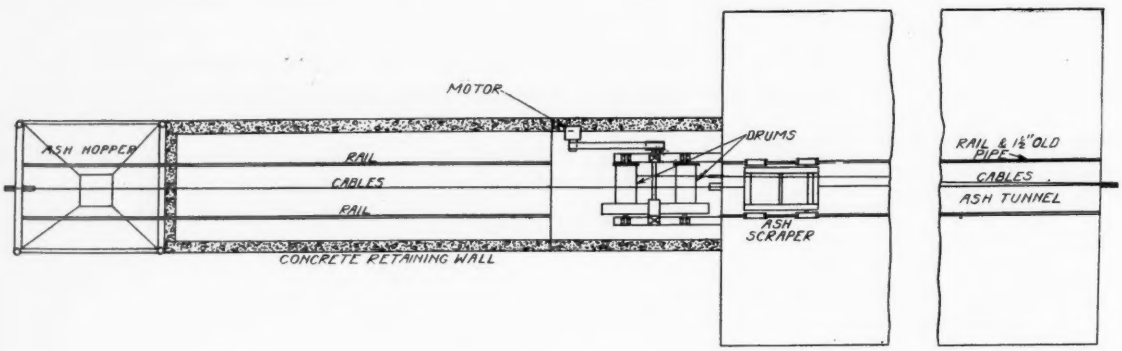


FIG. 1

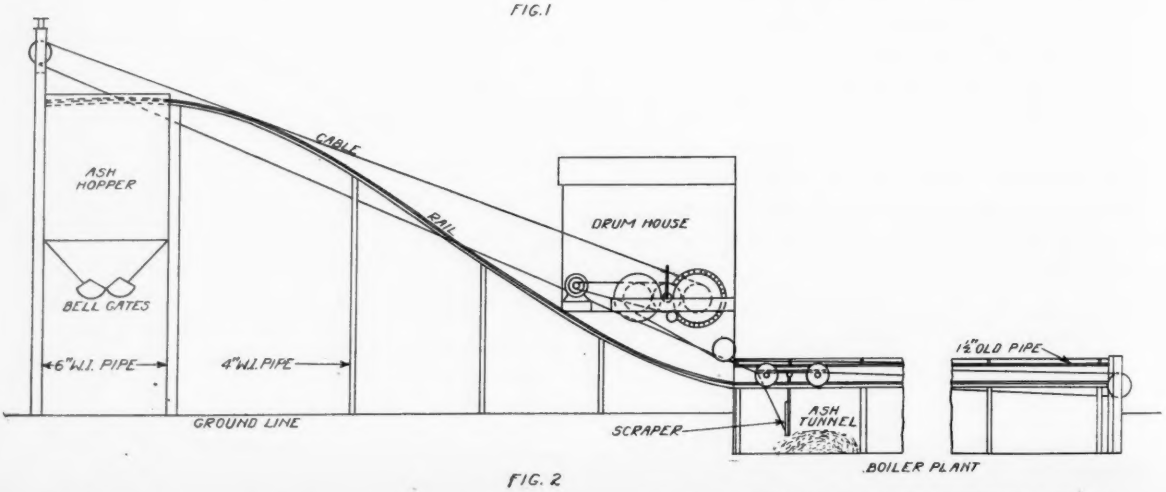


FIG. 2

FIG. 1. PLAN VIEW OF SCRAPER ASH CONVEYOR

FIG. 2. ELEVATION OF ASH CONVEYOR SYSTEM

stalled and removed three distinct types of conveyors in the past few years; finally built an ash conveyor on the principle of car and scraper. This has proved highly successful from the standpoint of first cost and also maintenance; first, because most of the conveyor was found in the scrap pile of the plant, and second—all the working parts are rolling surfaces, with the exception of one part which is the only one that comes in contact with the ashes.

Figures 1 and 2 give a general idea of what this ash conveyor consists. It is complete, requires no elevator or lifting mechanism; the ashes are scraped from the ash tunnel directly into the ash hopper; the workmen are not subjected to the gas and dust under the boilers as in the car system; the conveyor need only be operated at stated intervals, thereby leaving the ashman time to perform other duties in the boiler room.

The first thing to be considered in the building of this type of ash conveyor is the size of the storage hopper. On this depends the location of the hopper because the incline of the track to the hopper must be parallel to the angle of repose of the ashes, or the scraper will work against extra resistance on the incline. After the size and height have been calculated, which should be large enough for at least 12-hr. operation of the plant, the length of the incline can readily be determined.

The track was built of old 35-lb. rails which were discards at the plant. These were formed by bending when hot to the shape in Fig. 2, so that the car would not have any abrupt turns in its travel. The rails were fastened to 4-in. pipe which had previously been set in concrete, and made rigid by side bracing. Inside the boiler room an overhead rail made by bolting old 1½-in. pipe to the top of the ash tunnel, provided a means for keeping the car from jumping the track, if by chance any large clinker happened to get in the way of the scraper.

The car or ash scraper consists of a scraper hung on shaft from a four wheel truck, that moves on the rails. The wheels were made with double flanges to eliminate any tendency of the track spreading, and were keyed to shafts. One by 6-in. flat iron was used in the frame which was securely bolted together. On the under side were bolted the boxes for the wheel shafts, and from the center of the frame, the shaft for the scraper to turn on was hung, thus leaving all boxes and bearings above the track and free from any danger of grit from the ashes. The scraper was made in two pieces, one of ½ by 24 by 48-in. flat iron, and the other 1 by 6 by 48-in. The former plate was connected at each end by a hanger to the shaft while the latter was bolted to the lower edge of the large plate, and acts as a shoe as it naturally received the blunt of the scraping action. Both plates very slightly curved to facilitate the digging and scraping action, and were fastened by a chain to the front end of the carriage. This chain allows the scraper to work in only one direction, so that when the car is pulled into the ash pile, the scraper rides over the pile, while when the car is pulled out, the scraper tends to dig into the pile until the chain is taut; then it acts as a scraper pushing the ashes ahead of it.

Operating drums were made by taking two 4-ft. sections of 12-in. pipe and bolting solid flanges on each end, the center of the flanges being bored and keyseated for the drum shafts. Between flanges, the pipe was lagged with hard wood cants, and on one end of each drum shaft was keyed a cast iron friction pulley. Adjustable boxes were provided to take up the wear on the frictions. The driving mechanism consists of a shaft having a pulley on one end belted to a motor, and a paper friction on the other. This shaft was provided with a ball and socket and eccentric throw box to which was attached a lever. By moving this lever forward or backward, either drum could be operated. Proper brakes were provided and cables to car arranged, using large sheaves so that by rotating one drum, the car could be made to move ahead, and by rotating the other to move back.

The hopper used in this case is of 25 yd. capacity, and is provided with bell gates to facilitate the loading of trucks, wagons or cars. A retaining wall was built as shown by Fig. 1 from the boiler room to the ash hopper and tapered along the top on the same pitch as the rails. These walls eliminate the nuisance of having ashes scattered over the ground, and when filled with ashes, serve as a bottom for the scraper to work on. This does away with having a bottom to renew at intervals.

As to method of operation, the ashes are pushed into the ash tunnel, and allowed to accumulate for a definite period. The ash man then goes to the drum house, starts the motor and runs the car from outside the boiler room into the ash tunnel. As the car scraper strikes the ashes, it rides over the pile until the operator starts to run the car ahead. Then the scraper digs into the ashes and pushes or scrapes the ashes with it up the incline into the hopper. The operation consists in moving the ashes ahead into the hopper in scraperfuls, and the operator soon finds himself able to judge how far to allow the scraper to ride over the pile so that he will have a full load.

The conveyor is very simple, and the average man with a little care can operate and keep it in repairs. The shoe or wearing part can be replaced at a nominal cost, and without any lost time to the conveyor. The outfit will prove an economical and effective method of handling the ashes of the average plant, and by making the drums automatic in their operation, can be applied to large installations.

This conveyor has been in actual operation for the past year, and the maintenance cost has been small, limited mostly to the replacing of the wearing plate on the scraper.

U. S. Civil Service Commission announces an examination to be held July 19-20, for Laboratory Assistant, Senior Grade, to fill vacancies in the Bureau of Standards, Department of Commerce, for duty in Washington, D. C., or elsewhere, and in positions requiring similar qualifications, at salaries ranging from $1200 to $1380 a year. The register of eligibles resulting from this examination will supersede that resulting from the unassembled examination for laboratory assistant (announcement No. 354—Amended), receipt of applications for which closed on March 23. Appointees whose services are satisfactory may be allowed the increase granted by Congress of $20 a month. Competitors will be rated on general chemistry and elementary physics, mathematics (including differential calculus), an optional subject, from a given list, education, training, and experience.

Illinois Coal as a Source of Smokeless Fuel*

WHY SOME COALS ARE CALLED NON-COKING; EFFECTS OF OXYGEN; LOW TEMPERATURE COKING. BY S. W. PARR

UNTIL recent years the topic of coke and its production carried with it in America substantially no accessory thought or idea except the simple one of metallurgy, and to all intents and purposes coke in its original significance meant pig iron. Indeed, in a general way we measured our coke production in terms of pig iron, pound for pound. A ton of coke meant a ton of iron, or a ton of iron meant a ton of coke.

Recently, however, we have had somewhat rudely thrust upon us a number of related subjects such as tar and toluene, dyes and drugs, synthetics without number, some with notable and some with ignoble propensities, and then still more recently fuels—fuels of the fuel oil type, fuels of the motor spirit type and perhaps, most interesting of all, fuels of the gas type, in which there is neither ash nor clinker, neither smoke nor soot,

FIG. 1. DISTRIBUTION OF COAL IN EASTERN UNITED STATES

until, possibly because the wish is father to the thought, we imagine we can catch occasional visions of fuel gas as the predominating feature, and drugs and dyes and tars and even coke itself as merely by-products in the process of gas manufacture. It is a fascinating program and indeed one not without a very considerable amount of logical environment. So if there is reason in it with the premises fairly grounded in scientific fact, we may perchance be headed for "Spotless Town" without our really knowing it. Evidence toward this end may be somewhat scant or lacking or even possibly of a negative sort. If, for example, there is any virtue in the old saying that it is darkest just before daylight, then a cursory glance, for example at window sills and curtains and draperies, will justify us in thinking that from the standpoint of the old adage at least, the daylight must be pretty close at hand.

Indeed, we are even now approaching a state of mind where it may be considered in place to revive the paragraph from an address by Sir William Siemens, delivered in 1881, wherein he says:

"I am bold enough to go so far as to say that raw coal should not be used as a fuel for any purpose whatsoever, and that the first step toward the judicious and economic production of heat is the gas retort or gas producer, in which coal is converted either entirely into gas or into gas and coke."

But whatever the ultimate goal of accomplishment, it is very self-evident that coke is one and the most important of the way-stations. We will do well, therefore, to give more than passing attention to that topic. What is coke? Where does it come from? How is it made?

WHAT IS COKING COAL?

COALS of the eastern United States tend to run somewhat in parallel lines, the most easterly being anthracites, then a much longer line of semi-bituminous coals, and then a longer line of bituminous coals parallel in the main to the semi-bituminous fields, extending southward into Kentucky and westward into Ohio.

But the farther west we go the less we hear about coking activities, the great Connellsville region, for example, in southwestern Pennsylvania being the peak of the curve as we go west.

When we take into our vision the coal fields of the entire United States, we note from the standpoint of coking proclivities that the farther west we go the less credit is given the coals for the purpose of coke making. This is entirely consistent with our technical literature which relegates all those coals to the non-coking class which have a hydrogen-oxygen ratio of 60 per cent or less. The ultimate verdict vitally affects the vast coal fields of the mid-continental region as well as not a few extensive areas in Colorado and Utah, and in the great Canadian Northwest.

This is a rather serious matter for these regions, if it truthfully represents the situation. According to the map, showing the coal areas of the United States, one is impressed with the relative extent of the deposits, especially in comparison with the areas furnishing the coking coals of the eastern United States. Moreover, we were forcibly reminded during the war of the economic waste involved in long freight hauls that could be avoided. One steel works alone near Chicago producing less than 1/8 of the iron of that district uses a train load of coke per day. This would mean, let us say, three trains coming and three trains going, or six trains under constant movement to keep up that one supply. It is 460 miles from Pittsburgh to Chicago. It is, say, 100 miles from some of the principal Illinois fields to Chicago.

It should be stated at the outset that reference is here made to Illinois coals as a type rather than a product having geographical limitations. It is to be so considered in this discussion and as a matter of fact the characteristics as to high oxygen and non-coking character according to present standards would cover also the deposits

*From a paper before the Illinois State Academy of Sciences, April 29, 1922.

in Indiana, western Kentucky and the coals of all the states west of the Mississippi from Iowa to Oklahoma.

The importance of determining the really correct status for these high oxygen coals is further emphasized when we note the relative coal reserves of some of the principal producing regions. Colorado would seem to lead the list. But so much is inaccessible owing to the great depth of the deposits below the surface, that for purposes of this discussion, the Colorado reserves might for the present at least be set aside or given a lower place in the list. It would appear then that Illinois leads even West Virginia and Pennsylvania in the matter of potential quantity. The coal in this region is readily accessible, is mined with comparative ease and is contiguous to great industrial centers. Its relative value as an asset to the resources of the state is a matter of great importance. Similar statements would apply equally to the adjoining states where the same coal measures are met with.

So far as ordinary everyday purposes are concerned, it can be shown by reference to a chart on production, that aside from the particular adaptation to coke making, these coals are entirely on an equal plane with the coals of either West Virginia or Pennsylvania. For example —suppose we cut off from Pennsylvania the coal output which is mined for the purpose of cokemaking. The remaining tonnage will very well represent the relative rank of the several states with respect to their coal output for general industrial purposes. The annual output of coal for coking purposes is in round numbers about 65,000,000 tons. If we subtract that entire tonnage from the Pennsylvania yield of bituminous coal, the remaining 100,000,000 tons or less just about equals the annual Illinois output.

So much for the lay of the land. Now what is coal anyway?

Composition of Coals

This question was first installed so to speak in the chemical laboratory at the University of Illinois in 1902, and it is no exaggeration to say that today in this year of grace, 1921-22, it is more installed than ever. The slight hitch which occurred 20 years ago in the curve for the output of anthracite means that for the major part of that year the country at large was deprived of its smokeless fuel, and dire necessity was the mother of the practice of burning bituminous coal. Hence, the question, "What is coal?"

We have already seen that geographically the Illinois fields are about midway between the deposits of the East and the West. In a general way this is true also geologically. The fact is still further emphasized when we look at the coals chemically. In this chart, we have average analyses showing the composition of three types, a low volatile Eastern bituminous coal, an Illinois coal and a lignite. For our purpose in this discussion it is desired to call attention to one characteristic difference only, that is the shaded portion. This represents the residual oxygen or "hydroxy" compounds which remain from the initial organic material after all the vicissitudes of decay and geological alteration have taken place.

The chart is interesting because it illustrates at least the chemical method ordinarily employed for determining whether a given coal would coke or not. For example, if the ratio of hydrogen to oxygen is 1:1 or even ¾:1 or 75 per cent of the oxygen percentage, then the coal is considered to be in the coking class. But if the ratio of hydrogen to oxygen is, let us say, 0.6:1 that is 60 per cent or less, then the coal is classed as non-coking.

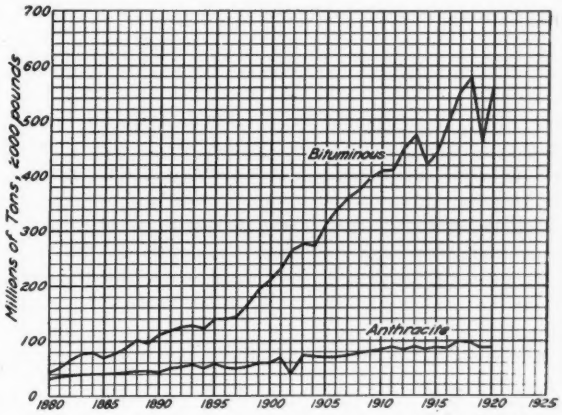


FIG. 5. GROWTH OF COAL PRODUCTION SINCE 1880

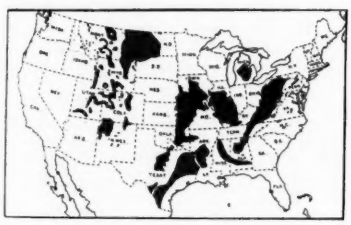


FIG. 2

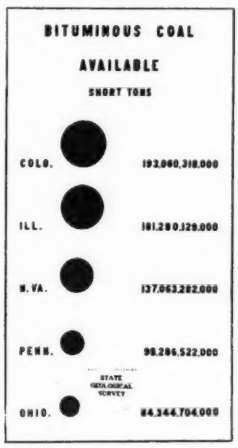


FIG. 3

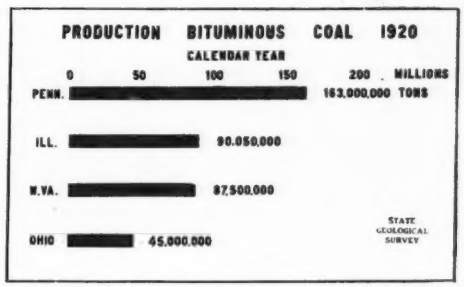


FIG. 4

FIG. 2. KNOWN COAL AREAS OF THE UNITED STATES FIG. 3. RELATIVE COAL RESOURCES OF FIVE STATES
FIG. 4. COAL PRODUCTION OF FOUR STATES FOR 1920

When one insists on a definition of these terms from those who make use of them, their answer really amounts to this: "A non-coking coal is one which is not being coked." They do not say it is one that cannot be coked, hence, fortunately the door is left open for the foolish to venture in.

This brings us directly to the question as to what is involved in carbonization—and by carbonization is meant not simply the destructive distillation of organic matter but the production at the same time of a strong dense coherent mass, capable of being handled and suited for use in either domestic or industrial appliances. Are there any underlying principles which play a fundamentally important part in the production of coke? In other words, is there a theory of carbonization applicable in a general way to coals of all types, the recognition or observance of which would enable us to attain the utmost limit of possibility in the matter of coke formation?

Let us review some of the existing theories. In the old beehive oven the coal having a depth on the floor of the oven of about 3 ft. was decomposed by the heat of the burning gases which were discharged from the coal into the upper part of the chamber. As the decomposition proceeded downward, the gaseous products of decomposition were obliged to pass upward through the highly heated layers, thus undergoing secondary decomposition. The carbon deposited on the surface of the coke in this process of decomposition gave a silvery lustre and was believed to play a part in the formation of the cell structure of the product.

Now, this is hardly to be credited with the designation of a theory. It is doubtless a description of some things that take place upon or around the coke after it is formed. It is distinctly silent as to what is going on down in the coal mass at the zone of active decomposition. The fact of the matter is that the coals worked upon in this fashion were for the most part from the Connellsville region, and would be entirely indifferent as to what theory was proposed for their coking property. They would coke just as well under one theory as another or under no theory whatever.

Effect of Oxygen on Coking

We come next to a study of coals resulting from the use of solvents which separate the coal without decomposition into two portions, one of which has distinctly non-coking and the other has distinctly coking properties.

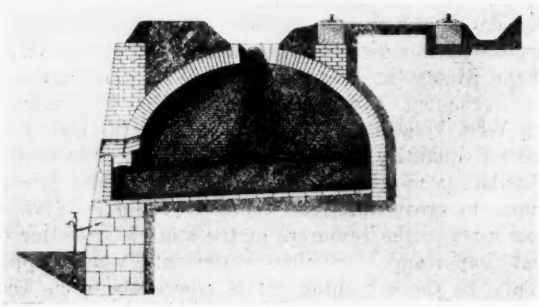


FIG. 7. BEEHIVE COKING OVEN

We have here the first real forward step in the study of carbonization.

In our own laboratory at the University of Illinois, it continues to be the most prolific source of information and furnishes the most numerous avenues of approach to the fundamental characteristics of these two type substances. It is along these lines moreover that we have made the most encouraging progress in our studies as to the underlying principles involved in the carbonization of coal.

In the chart here shown, we have an illustration of the two type substances, the larger amount being the insoluble residue or non-coking substance and the smaller portion being the so-called resinic or coking material. The amount in each sample will give also a general idea of the relative proportion of these two substances as found in Illinois coals.

Now from the discussions that have thus far been presented in the literature, it would appear that the soluble material at the right, Fig. 8, is looked upon as

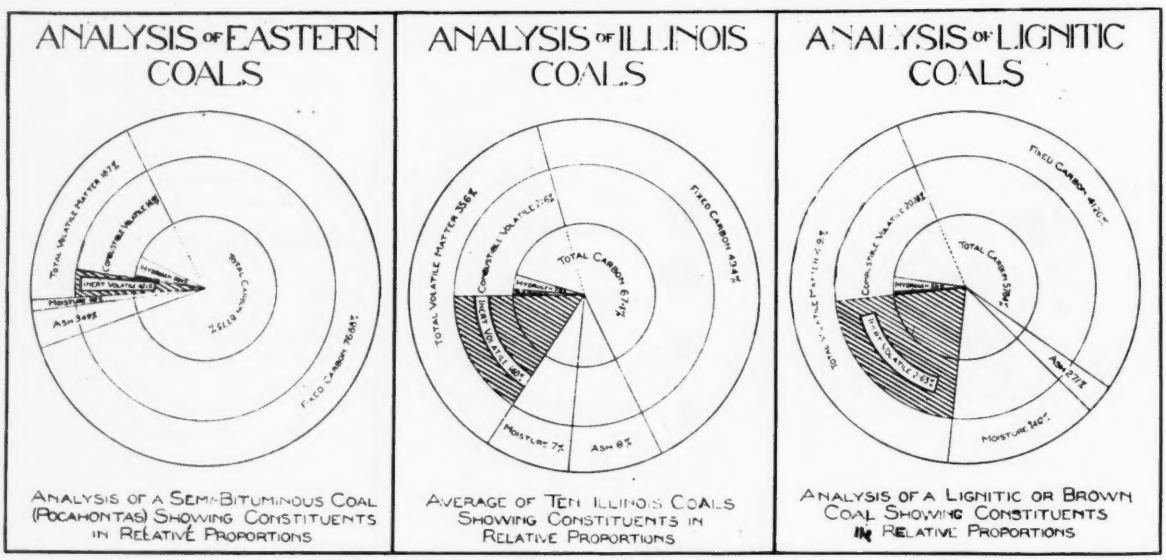

ANALYSIS OF EASTERN COALS
ANALYSIS OF ILLINOIS COALS
ANALYSIS OF LIGNITIC COALS
ANALYSIS OF A SEMI-BITUMINOUS COAL (POCAHONTAS) SHOWING CONSTITUENTS IN RELATIVE PROPORTIONS
AVERAGE OF TEN ILLINOIS COALS SHOWING CONSTITUENTS IN RELATIVE PROPORTIONS
ANALYSIS OF A LIGNITIC OR BROWN COAL SHOWING CONSTITUENTS IN RELATIVE PROPORTIONS

FIG. 6. ANALYSIS OF TYPICAL COALS

the active coking constituent and that the insoluble material is inert and when it does not predominate in too great an amount over the soluble material, a good coke results. In this view of the theory of coke formation, the active coking material, the soluble or so-called resinic bodies, play the part of a binder to the non-coking portion. This theory would seem to have substantial confirmation by so simple an experiment as the following: Suppose we take a sample of the original coal of the type here used and coke the unaltered material in a crucible according to the ordinary procedure for the determination of volatile matter. We shall obtain a sample of normal coke such as this particular coal may be expected to produce. If now we take these type substances as illustrated in Fig. 8 and reassemble the non-soluble or cellulosic residue with the proper proportion of the coking substance, we shall have after the carbonizing process again a sample of coke which can in no way be distinguished from the first or normal sample. Hence the demonstration of the simple binding function of the resinic material would seem to be established.

But suppose now we proceed a few steps further. We know that freshly mined coal has a tremendous avidity for oxygen and that if we permit a finely ground sample of Illinois coal to become fully saturated with that element, all tendency on the part of the coal to produce coke is lost. Let us, therefore, saturate a portion of each of these subdivisions with oxygen and recombine them in their proper proportions, and for comparison, to make the circle complete, we will retain the sample already made in which both subdivisions were in the fresh or unoxidized condition. We have here illustrated on the left, one sample of coke which has resulted from a recombination of the fresh or unoxidized portions in their correct ratios, and at the right we have a sample of coke resulting from a recombination in correct proportions of an oxidized resinic substance with a fresh or unoxidized residue. Note especially that the resulting coke is indistinguishable from the normal sample at the left in the figure. This result is quite the opposite from what would be expected. If a coal which has been completely oxidized will not coke, and if the resinic matter carries the coking principle, then complete saturation of the resinic portion with oxygen should destroy its coking or bonding property. But it does not, the resulting sample being indistinguishable from the standard made for comparison.

Now we will reverse the process, saturating the non-coking cellulosic residue with oxygen and leaving the resinic material in the fresh unoxidized state. Upon recombining and carbonizing, we have the result as shown in Fig. 10. Here the coking property has been completely destroyed.

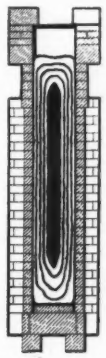


FIG. 11. PROGRESSIVE COKING LINES IN BY-PRODUCT OVEN

Evidently our theory of the coking process will have to go further back than the simple idea of a binding material, to a study of the factors that enter into the properties of both constituents and the conditions that affect their modification on the one hand or their preservation and indeed their accentuation on the other. Here it would seem from this illustration that we have worked out an answer to the question how not to make coke instead of the question "how is it made?" On the contrary, it may very well happen that the most direct information as to how to do a thing may come from positive evidence as to how it should not be done.

FIG. 8 FIG. 9 FIG. 10

FIG. 8. COAL SEPARATED BY SOLUTION INTO NON-COKING AND COKING CONSTITUENTS. FIG. 9. SAMPLES OF COKE FROM ORIGINAL COAL AND REASSEMBLED CONSTITUENTS, THE BINDING SUBSTANCE HAVING BEEN OXIDIZED BEFORE COMBINING. FIG. 10. EFFECT OF OXIDIZING THE NON-COKING REISDUE ON COKING PROPERTY OF COAL

By way of illustration taken from some of our experiments: Here is a high volatile eastern coal with excellent coking properties. It has in its normal condition a hydrogen-oxygen ratio of 73 per cent. Now by saturating with oxygen under suitable conditions whereby it has taken up approximately 50 times its volume of oxygen, it has a hydrogen to oxygen ratio of 33 per cent, and has dropped out of the coking class absolutely as we would expect. By suitable procedure,

however, and recognition of the part that the cellulosic residue may play in the carbonization process, it is possible to produce a normal coke even from this highly oxygenated sample which, as we have seen, was reduced in its H:O ratio from 73 to a percentage of 33.

Low Temperature Carbonization

Space will not permit of details in connection with the behavior and control of these factors. One point of fundamental importance and interest must suffice. It relates to the property of all coals in general and high oxygen coals in particular of carbonizing with the evolution of heat. The interactions involved therefore and

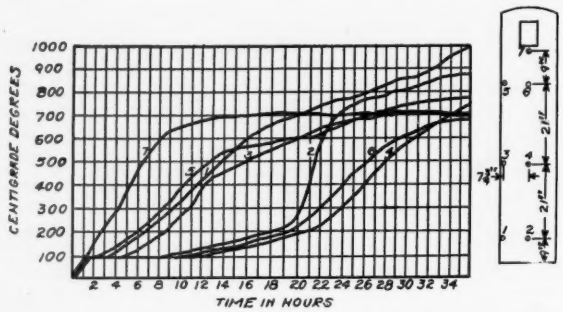


FIG. 12. PROGRESS OF TEMPERATURE CHANGES IN BYPRODUCT OVEN

which it is essential to control are exothermic in character. This fact should be coupled with another important one, namely, the control of these interacting substances can best be carried out under low temperature conditions or carbonization, that is, at temperatures below approximately 750 deg. C. (1382 deg. F.).

Fortunately for our purpose this fact of exothermicity and of carbonization are not only compatible with each other, but we believe are essential to the successful accomplishment of the prime purpose we seek, namely, the carbonization of high oxygen coals.

In attempting to maintain low temperature conditions, the first problem with which one is confronted is the physical impossibility of conveying heat into the center of a non-conducting mass without maintaining at the exterior a high heat head for the purpose of driving the heat forward through the insulating layers of coke that are continually in the process of formation. Some idea of the actual conditions involved may be seen from Fig. 12 here presented. The diagram at the right is a cross-section of a byproduct oven with points indicated where temperatures within the coking mass were taken. It will be seen that in an extended 35-hr. coking period, the temperatures at the center of the mass did not reach the stage of decomposition, say 250 deg. C. (482 deg. F.) until after 20 hr. The obtaining of heat transmission therefore by simple process of conductivity is at once seen to be impracticable if low temperature conditions throughout the mass are to be maintained. It is at this point that we have attempted to use the exothermic reactions involved in the carbonization process. These exothermic reactions are directly due to the oxygen compounds of the raw coal. By reference again to the chart, Fig. 6, showing the makeup of an Illinois coal, we can at once see the possibility of a very considerable amount of heat available from this source. The high oxygen content therefore becomes an asset instead of evidence of a nullifying influence in the process of carbonization. The direct measurement of this exothermic heat has been one of the most interesting as well as one of the most elusive features of the problems involved.

Let us assume, by way of illustration, that in the case of an average Illinois coal, we have an amount of this potential heat equal to 4 per cent of the total heat of the coal, or approximately 500 B.t.u. per pound. Now, if we can drop a mass of coal into a retort whose walls are heated to 750 deg. C. (1382 deg. F.) and start off the exothermic reactions in such a manner that they will become autogenous, they will, of course, pass beyond the outer zone of heat furnished from the walls of the oven and proceed to the center of the mass regardless of either the heat head at the surface or the insulating property of the mass.

In the illustration here shown, these conditions have been secured. Note particularly that a narrow zone at the outer rim shows a coke formation which has been due to the direct application of heat from the walls of the retort. Beyond this zone and thus soon out of reach of the exterior heat, the reactions became autogenous and quickly penetrate to the center. Naturally also we would expect that in order to travel alone, they must have at least slight surplus of heat at every stage of progress inward which would thus be cumulative in effect and at the end of the process would show a higher temperature at the center of the mass than at any other point and this correctly represents the uniform condition at the termination of an experiment. Incidentally

FIG. 13. SAMPLES OF COKE FROM ILLINOIS COAL AT LEFT AND EASTERN COAL AT RIGHT

also it is interesting to note not only the texture and cell structure peculiar to the carbonization that occurs under these conditions, but also that the sample at the left is from an Illinois coal with the high oxygen value as already shown in the chart, while the sample at the right is from a high volatile eastern coal which would at once be placed among the coking coals because of its low oxygen content. The texture, strength, density, etc., of the two samples seem to be very much alike.

The question will at once arise in your minds as to why this effect is not secured in the regular byproduct coke oven. The wall temperature starts the coal at even a higher stage, say 1000 deg. C. (1832 deg. F.), while we are using from 700 to 800 deg. at the start. Why do not the exothermic reactions occur and travel autogenously to the center in the usual method of procedure.

A brief bit of figuring will answer the query. Let us recall that we are assuming a source of heat of this sort equal to 500 B.t.u. per pound. Now if we start out with a mass of coal at 30 deg. C., or say 100 deg. F., and plan to raise the temperature of the mass to 800 deg. C., or 1500 deg. F., we must provide heat enough to raise the mass through 1400 deg. F. Roughly, the specific heat of coal is 50 per cent that of water, hence it will require 700 B.t.u. to do the work of raising the temperature of the mass without taking into account the latent heat of vaporization for the water present. But we have to our credit only 500 B.t.u.; hence, no matter how good a start we give to the reactions, they will cease to operate as soon as we pass beyond the zone of external heat where that effect is lost by reason of poor conductivity. As we say when attempting to start a fire with green or wet wood, "the fire goes out."

On the other hand, if we raise beforehand the temperature of the mass to say 300 deg. C., or 600 deg. F. slightly below the point of active decomposition, the work remaining to be done is now that of raising the temperature of the mass through only 800 deg. F., or in terms of heat units, we require only 400 B.t.u. Since we assume 500 B.t.u. at our disposal and expend only 400, we have a slight margin to our credit which accounts for our cumulative effect and higher temperature in the center at the close of the process.

This, therefore, in a general way sets forth what we believe to be the essential factors that must be taken into account in the coking of high oxygen coals.

A summarized view would indicate that the theory of carbonization needs to be rewritten or revised in such a manner as to cover the case of high oxygen as well as low oxygen coals. That when the factors are thus understood and their influence properly controlled, the so-called non-coking coals may be brought into the coking class, and that the low temperature condition is the one which lends itself most readily to the carrying out of the carbonization process. Perhaps the most important of all is the utilization of the exothermic property whereby the slow effect by conductivity is replaced by the relatively quick procedure of preheating the coal thus securing autogenous chemical reaction throughout the mass.

For the present at least we are content to leave the ultimate goal of fuel gas and stop at the coke stage, especially in view of the fact that the coke produced in this manner comes into the class of smokeless fuels with combustion characteristics quite comparable to the anthracite or semi-anthracite type.

Cost Accounting System for Small Utilities---III

COMPLETED COST SHEETS AND HOW THE BOARD USED THEM. BY MAC HANSON

THE MECHANICAL process of drawing the Electric Utility Cost Sheet, Fig. 3, was as follows: Tom required more columns than on the Steam Generation sheet, so he unfolded a sheet of legal cap paper and pasted a one-fourth length of a sheet onto the end. He ruled the sheet lengthwise, as he did the steam generation sheet, into 12 divisions for the monthly records, each monthly division having a black line on which he entered monthly costs, and a red line to carry the "cost to date" of each column, as explained about the steam generation form. The sheet was also ruled crosswise. The first 10 columns were two lines wide and constituted the Income Statement, which was not a part of the cost finding proper. The last three columns were two lines wide and contained general information, not cost items. The headings of these three columns are self-explanatory.

The remainder of the sheet was ruled one line wide and constituted the cost sheet proper. The cost sheet was divided into 13 sections, with headings as shown. The section entitled "sub-grand totals" was entered merely to fit the requirements of the Commission's annual report blank.

The "power" section had two sub-sections under it, viz., "operation" and "maintenance." The Commission's form called for these same sub-sections under transmission and under distribution; but Tom considered that Kineford's plant had no "operating expenses" on its transmission and distribution systems and charged all expenses of these departments to "maintenance." Tom further considered that Kineford's plant did not have both a transmission and a distribution system, or rather he considered that they had, but that they had no way of separating the expenses of the two. So he used the total expenses of both departments and split them 50-50, except transformers, which went to transmission alone.

The sheet is shown in three sections in the cut for mechanical reasons, but was made by Tom as a continuous sheet.

The monthly totals of expenses were entered in the proper monthly division, and in the proper column under the proper sub-section and section, in *black* ink on the upper lines. The "total to date" of each column were entered on the lower lines in *green* ink.

Where and how to get the monthly cost items will be explained after all the cost forms are explained. When the Grand Total Expense is ascertained, it is carried to column six of the Income statement. The entries for columns 2, 3, 4 and 5 Tom received from the town treasurer.

The Water Utility Cost Sheet, Fig. 4, was made up exactly like the Electric Utility Cost Sheet, except that it had no Transmission section, nor Consumption section. The column headings under the Income Statement were the same as on the Electric sheet. Likewise under Power, Operation. Under Power Maintenance the headings were as shown.

These two sheets, Figs. 3 and 4, are the principal cost sheets and their greatest value is in the records of cost which they display. Like Figs. 1 and 2, they show a lot of things besides mere costs, though, for instance, Tom's 1921 sheets showed the Town Board that they had overdone the improvement and betterment work for the year. Pipe line betterments, electric line betterments, hand stoker installation, generator overhauling, etc., had run over $5000, whereas the total expenses of the light and water system was $18,433,

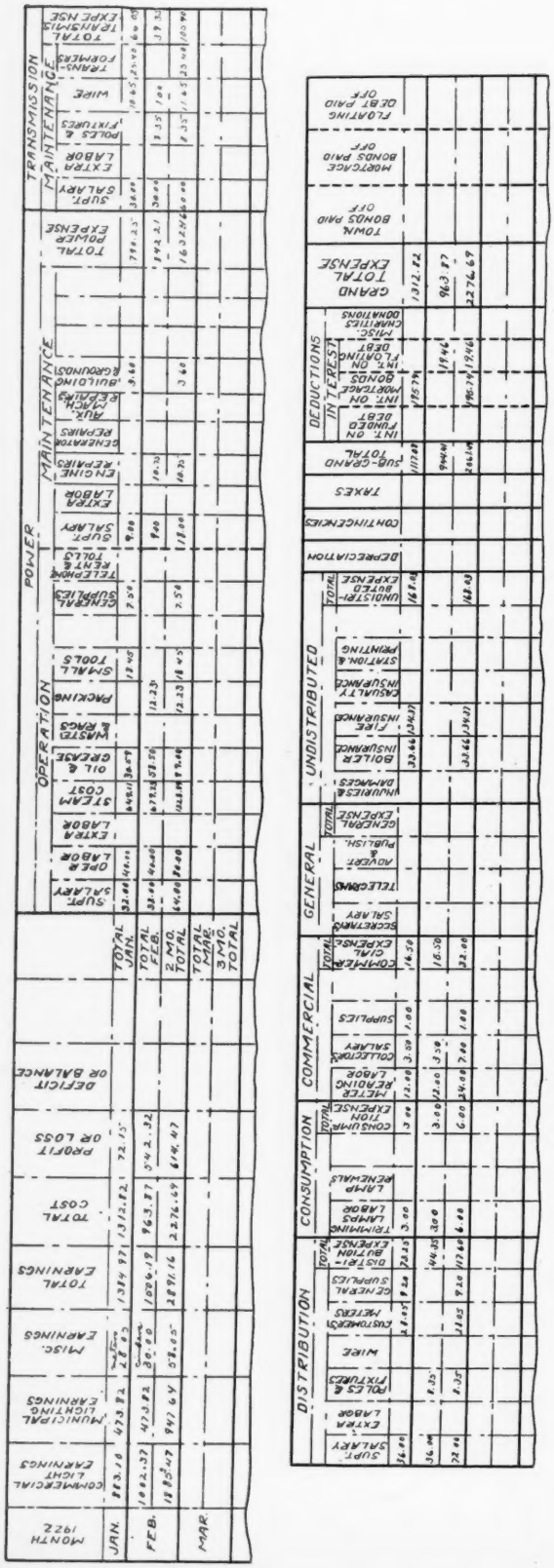


FIG. 3. ELECTRIC UTILITY COST SHEET OF KINEFORD ELECTRIC AND WATER UTILITY

including this $5000. The percentage spent for betterments was excessive for one year, being over 27 per cent of the total expense.

Much of this betterment work could have been delayed without monetary loss or other damage. The town board recognized this fact, too, after it saw Tom's sheets, and adopted a budget system for 1922—another good result of keeping costs. The comparison of one year's costs with previous year's costs is always a source of much valuable information and often leads to investigation which brings about big savings or checks great losses. But costs can't be compared without cost sheets.

Tom himself feels that the greatest advantage of these cost sheets lies in the fact that the Town Board knows what each department is costing and also each item under each department. Heretofore, they knew only the total receipts and total expenditures, never what the expenditures were for. Heretofore all Town Boards paid the claims which the superintendents brought in, without question, without knowing what the materials were purchased for, whether they were needed, or even whether they were used in the business at all.

Since the installation of this cost accounting system, the Board wants to know why the bill for wire was so much more this month than last; or why it took so much labor to do this or that; etc. And Bob Johnston would explain that the light and water committee had authorized him to repair the line running from Kentucky Ave. south across the railroad tracks, as it was endangering the telegraph wires.

"Why did you have to buy a new wire for that, Bob?" Buck Orth inquired.

"That old wire has been up since the line was first built and the insulation was off in patches the whole length. That's the 2300-volt line I bought new wire for. It wouldn't do to run any risks of the 2300 ever falling on the telegraph wires with no insulation on the 2300. Town might have to pay a heavy damage. So I bought new wire for that and will use the old wire for some 120-volt circuit."

"Here's an item of $77 for transformers," Jack Louder said. "Is that for one transformer?"

"That's the 7½-kv.a. the Board told me to buy and install at the Lumber Company. The one there now is a 1-kv.a. and not only carries the Lumber Company's motor, but has seventeen residences on it. The neighbors have to make arrangements with each other as to when they are going to iron, for not over two can iron at once and none of them can if the Lumber Company's motor is on. We ought to buy several more of these transformers. Lots of those in service are only ½-kv.a."

"We'll have to get along with them for awhile yet," Jack declared. And why? Because the cost sheets showed him that the town had spent all it wisely could for betterments for awhile.

Or, take the water utility cost sheets. For many years the following bad service conditions existed: There were eight different service sub-mains, leading from the main to the residences, each of which eight sub-mains served from five to nine residences. And yet all eight were ¾-in. pipe. When one customer was using water, the rest could get none. If two or three tried to get a drink at once, it took them two or three minutes to get a glass of water. One customer declared that when he wanted to get a bucket of water to water his stock, he

had to go around and tell the rest of his neighbors to leave their faucets closed. This man was the last one on the sub-main serving eight residences.

The people had kicked to previous Town Boards often and repeatedly. But previous boards had no funds. No wonder. They had no cost accounting system to aid them in controlling their finances. But the 1921 board made betterments on seven of these sub-mains. They installed 2-in., 1¼-in. and 1-in. pipe on each to take the place of the ¾-in. They did this betterment work from month to month and were never overdrawn at the bank.

They had to stop with seven, as there were other betterments necessarily made at the plant. But the cost sheet showed that they wound up the year 1921 with a profit of $121.28. Three cheers! The first time such a thing had ever been done in our town. The people liked the work of the Town Board so well that neither political party would put up a ticket for the municipal election last fall, and thus forced the old board to hang over. Any of them will tell you that the cost finding system enabled them to spend the money wisely, as they knew at all times how the plant stood financially.

Here's another example of what a cost finding system will do. You remember I stated that the board adopted a budget system. They never could have done this wisely without a knowledge of their costs. Mayor Dan'l had appointed the light and water committee and the clerk to draw up a budget for 1922. While studying the cost sheets in order to work out a budget, Buck, Jack and Tom also found where they could cut down expenses for 1922 by limiting the betterment work; by savings due to lower prices on some materials; by using the boiler with the hand stoking grates almost entirely and using the boiler with the shaking grates only when and as long as necessary to clean the other boiler; by reducing the water pressure from 65 lb. to 40 lb., which they could do without impairing the service since the high pressure had been carried to accommodate those customers who had been on ¾-in. sub-mains; by cutting off the free electric service given the band-stand, the 500-w. lamp on top the elevator, and certain other free service; by tightening up the boiler settings and smoke stack; by putting a draft regulator in the breeching to the stack, and other such ways. The stoking grates themselves saved 50 cents a ton on each and every ton of coal burned, because the superintendent now used screenings altogether, whereas on the hand-shaking grates he had to use egg or at least mine run.

In fact, this town board learned more about how to run a plant on a paying basis, after it had established its cost accounting system, than all the town boards before it had learned from 1903 to 1921. This committee on budget discovered that they could safely figure on $5000 less expenditures in 1922 than in 1921 by careful oversight and management. And, after receiving these findings, the Town Board decided to apply to the Commission for a reduction in rates from 15 cents to 12 cents. Or, rather, to 13 cents, with 1-cent discount if bill is paid by the 20th of the month.

I'll predict that the present Town Board has a lifetime job if they keep this good work up. Besides this, the Town Board members take a great interest in the plant and its operation, a thing they never did before the cost accounting system was established. They visit the plant to see how this is done, and if that little plan they suggested has worked out for a saving, or if Bob finally got that hot box difficulty solved. And Bob himself is keyed up. For he knows that, if he exerts himself to save or improve, the board is going to know it and appreciate it. All this, and a hundred things more; yet the cost system has only been in use about six months.

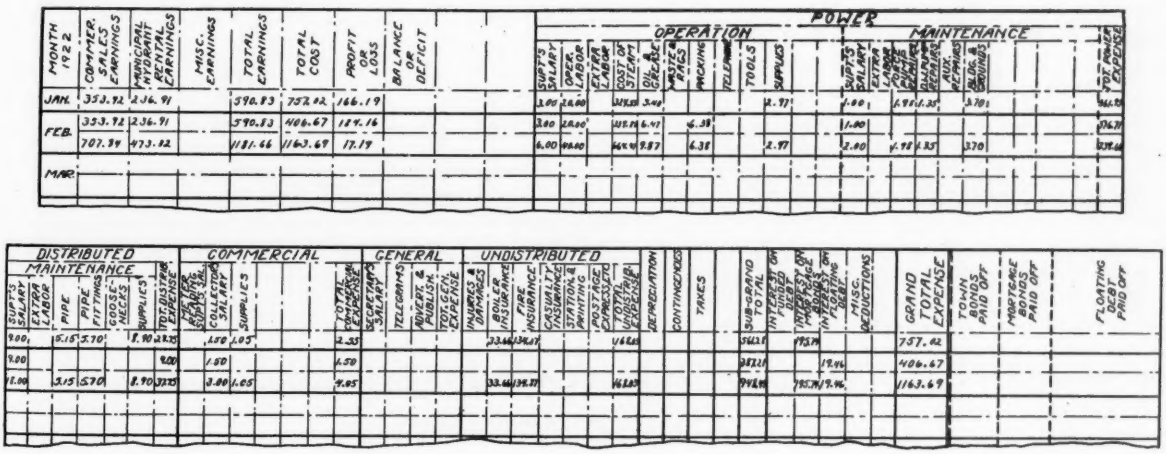


FIG. 4. WATER UTILITY COST SHEET

The fifth and last form that Tom worked out was a "Recapitulation Sheet," Fig. 5, on which he gathered the totals of each section of the Electric and the Water Sheets into one total.

Tom made this sheet as follows: He unfolded a sheet of legal cap paper and ruled it lengthwise, from one edge to the other (i. e., paying no attention to either marginal ruling). He ruled it with lines 5/32 in. apart. The first line was 19/32 in. from the edge of the paper. This gave room for marginal headings. Every fourth line was red and the space between these red lines was a monthly division. There were 12 of these divisions, of course.

Each monthly division was ruled into four sub-divisions by the other lines drawn. The first and second

line of each monthly division was *green*, the third was *black*, and the fourth, as mentioned above, was *red*.

On the first green line was entered, in proper column, the totals from the Electric Sheet. On the second green line, the totals from the Water Sheet. On the third, or black, line, the "total this month" of the above two items was entered. On the red line the "total to date" was entered.

Tom ruled the sheet crosswise into columns, all of which were two lines wide. The first 10 columns constituted the "Recapitulated Income Statement." The next column contained the titles of the monthly subdivisions. Then came the cost sheet recapitulation proper. Then followed the three columns for funded debt paid off, mortgage debt paid off, and floating debt paid off.

This completed the "Recap. Sheet" and also the full set of sheets, which were five, viz., Coal Cost Sheet, Steam Generation Cost Sheet, Electric Utility Cost Sheet, Water Utility Cost Sheet and Recapitulation Cost Sheet.

This "Recap. Sheet" has several advantages. If the board wants to know the cost of running the central station on the first four sheets. Cost of oil is found by adding the totals of the oil columns on the Electric and Water Sheets. Cost of labor for maintenance of delivery systems can be found by adding the totals for labor under the transmission and distribution sections on the Electric and Water Sheets. Almost any item of expense, in almost any manner desired, can be obtained from these sheets.

The Board was surprised to find that oil and grease cost $452.79 for the year 1921. Of this, the Electric utility was charged with $396.82. The total cost of manufacturing was $13,050.55; of delivery was $3235.45; of general expense was $2147.36. This latter included about $1000 of interest charges and about $400 for all kinds of insurance.

After Tom had worked out his cost accounting forms, the Board made arrangements with him to run them for the year 1921, setting his salary for this at $75 a year. I will explain the system he worked out as to "where and how to get his cost items." Tom hunted up the claims (or bills and statements of account) and arranged them in date order and numerical order as they were recorded in the minute book when allowed by the Board. He then pasted them in a bill file, using one

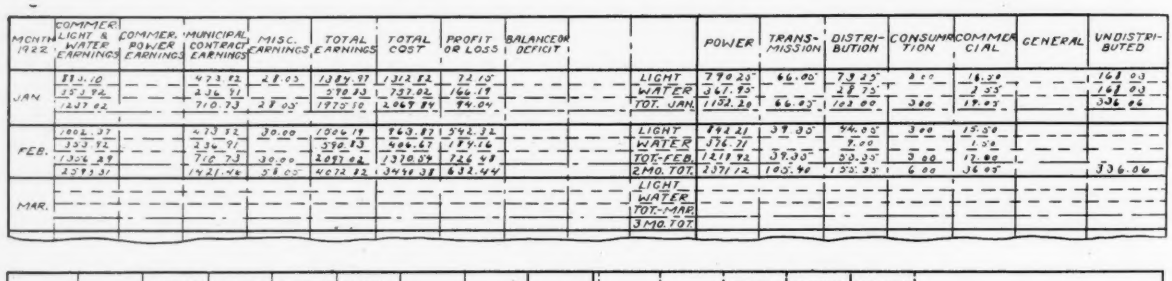


FIG. 5. RECAPITULATION COST SHEET

tion, i. e., the manufacturing end, they get that information from the Power column. If they want to know the cost of the delivery systems, they add the totals of the transmission and distribution columns. The total "general" expense they obtained by adding the totals of the following columns: consumption, commercial, general, undistributed and interest columns. Thus the board can know what it costs to "make" the current and water, what it costs to deliver it, and the general expense of operation.

Should they wish to know separately the cost of making electric current and of pumping water, these are shown separately as monthly totals on the Recap. Sheet under Power column, or can be had on the Electric Sheet and the Water Sheet in the column headed, "total cost of power."

Cost of coal is found on the Coal Cost Sheet. Cost of steam on the Steam Generation Cost Sheet. Cost of "all labor" is found by adding the totals of all labor columns

page to a payment date—or more pages, if necessary. He wrote the date at the top of the bill file page.

He then compared the claims with the stubs of the checks issued in payment, to see that they agreed. He entered the number of the check paying that claim on each claim. After he had all claims pasted in the bill file, he went through the claims and put marks (which will be explained later) on each claim showing to which sheet, to which section of that sheet, and to which column of that section that claim was entered, using a green pencil to make these marks.

He then took three work sheets, heading them "steam generation," "electric" and "water," and drew several columns on them freehand; and headed these work sheet columns with the section and sub-section headings on his cost sheets. He then looked through his claims for one month—let us say, January—and entered the claims to the proper columns on his work sheets, as indicated by the green pencil markings on each claim. As he entered

each claim on his work sheets, he marked that claim "Ck" (for "check") with a blue pencil.

After running all the claims for that month, he totaled his various items in each column on the work sheets, and carried these monthly totals to the proper columns on his cost sheets.

He did not run the superintendent's salary onto the ork sheets because, as has been explained before, he had worked out an arbitrary distribution of this expense and had made a typewritten record of it. Therefore this salary item was carried to the cost sheets directly from the typewritten record, but the claim for superintendent's salary was marked with a blue "ck" after the salary entries were made. Tom did not enter the coal cost items onto the work sheets, either. These coal costs were kept as single entries, not monthly totals, therefore he ran these items direct from the claims to the coal cost sheet, marking each such claim with a blue "ck" when it was entered. All other claims were first entered on the work sheets, so as to show as monthly totals. After January's monthly totals had been entered on the cost sheets, the January work sheets were folded together and filed, not destroyed. New work sheets were ruled for February.

Tom made a list of his marks and abbreviations used, in marking claims with the green pencil, to show the distribution of the various claims to the several cost sheets, sections and columns. This list is as follows:

E—Electric utility cost sheet.
W—Water utility cost sheet.
SG—Steam generation cost sheet.
O—Operation sub-section.
M—Maintenance sub-section.
P—Power section.
T—Transmission section.
D—Distribution section.
Consp—Consumption section.
Com—Commercial section.
Gen—General section.
Contin—Contingencies section.
Und—Undistributed section.
Ded—Deduction.
Dep—Depreciation.
Coal—Coal.
Sal—Salary.

"Ck," in blue pencil, means that this claim has been properly entered on the cost sheets.

The use and meaning of the abbreviations is illustrated as follows:

"EPOsupplies"—Enter this on Electric Utility Cost Sheet, Power section, Operation sub-section and supplies column.

WDM pipe ftgs—Enter this on Water Utility Cost Sheet, Distribution section, Maintenance sub-section and pipe fittings column.

Coal—Enter this on coal cost sheet.

Sal—Enter this salary item as per typewritten sheet covering distribution of salaries.

SGM grates—Enter this on Steam Generation Cost Sheet, Maintenance section, grates column.

E Consp lamp renewals—Enter this on Electric Utility Cost Sheet, Consumption section, lamp renewals column.

A few illustrations of claims properly marked are given in Fig. 6; also illustration of work sheets mentioned above.

The bill file was the only book form that Tom used. His complete system consisted of a bill file and five cost forms. The earnings he received from the treasurer.

It will be seen from the above that a state traveling auditor, or anybody on earth, could readily check up Tom's distribution of costs, in making an audit of his sheets. Should you use this system with a clerk to keep it, and wonder why some item of expense was so high, you could easily thumb through the bill file and find every item that was charged to that account.

This system of accounting does not take care of the receipts or credits. They must be obtained from some other source. It was designed merely to have an accounting of the costs. But the principles and system here explained can readily be expanded to care for the receipts, if desired.

A "journal of receipts" could be kept, which would compare to Tom's bill file. The distribution of the items of receipts can be indicated on the journal by abbreviations or marks such as Tom marked on his claims. Separate forms can be ruled for the various departments, or can be attached to the cost forms, by lengthening them. These income forms would carry the necessary sections and sub-sections and columns required; and the information contained on these "income" forms could be recapitulated on an "Income Recapitulation Sheet."

The system of cost finding which Tom invented meets the principles of bookkeeping as practiced in regular systems of accounting. The general idea of accounting as kept with books is as follows: Original entries of debits and credits are made in a journal which has debit and credit columns. These journal entries are posted to a "ledger of accounts." This accounts ledger has separate pages, or accounts, for each item of operating or direct expense, such as fuel, labor, oil, water, repairs, etc.; usually one account for all overhead or indirect items of expense; one account called "Profit or Loss," and other accounts as needed. Each of these accounts in the accounts ledger has a debit and credit column.

Then each month the totals of each of these accounts, both total debits and total credits, are carried over into the general ledger, which thus gives the recapitulation of accounts and shows the profit made or loss incurred.

In Tom's system of accounting, the bill file is the "journal of debits." The first four cost sheets are his "Ledger of cost accounts." The Recapitulation Sheet is his general ledger. As in regular bookkeeping, postings are made from his journal (bill file) to his accounts ledger (cost sheets), and the totals of his accounts are carried to his general ledger (recapitulation sheet). Tom's system does not, however, make postings from the bill file to the cost sheet by single items, as does the bookkeeping system, but by monthly totals drawn off onto a work sheet from the bill file, as I have explained heretofore. But this very fact simplifies the clerical labor of posting, which is a thing greatly to be desired, and makes the cost forms more readily understood, which is the supreme thing to be desired.

Tom's system of cost accounting has at least four distinct advantages over the book system of accounting. It not only distributes the operating expenses to the individual accounts, but also the overhead, or indirect,

expenses to individual accounts. It distributes the expenses to the proper department, or section, of the business, which a book ledger of accounts does not do. That is to say, it analyzes the costs as it goes along. For example, an accounts ledger would merely show the total amount spent for labor during the month; but Tom's cost sheets would show the exact amount spent for labor under each section and sub-section of the business, and they would also show whether it was superintendence labor, operating labor or extra labor.

The third advantage of Tom's system is that it is a "visible" system, whereas a book ledger of accounts is a "blind" record. Upon opening Tom's record, every cost of that utility or department is immediately visible—in plain sight. Upon opening an accounts ledger only one account can be seen at a time.

And, fourth, Tom's system greatly simplifies the matter of posting from journal to ledger (from bill file

I saw Tom yesterday and told him I was writing up his cost system. He said he had just finished ruling his forms for 1922 and to tell you the following: It took him 2 hr. to rule the lengthwise lines on all five sheets, without any headings or crosswise lines. This included, though, the pasting of the quarter length of legal cap paper onto the end of the Electric and the Water forms. He said that the Recapitulation sheet took over an hour itself, as the measuring of spaces and drawing of three colors of lines made slow work. He had no tools to work with except an advertising yard stick—that is, a soft wood, splintery, crooked yard stick—a common penholder with steel pen point, a table with cracks in it, and yet drew very creditable forms. No doubt a drawing pen and a good straight-edged yard stick would have made the work pleasanter.

Tom said it took him 30 min. to draw the cross lines on all five sheets, and 2 hr. to write the headings on all

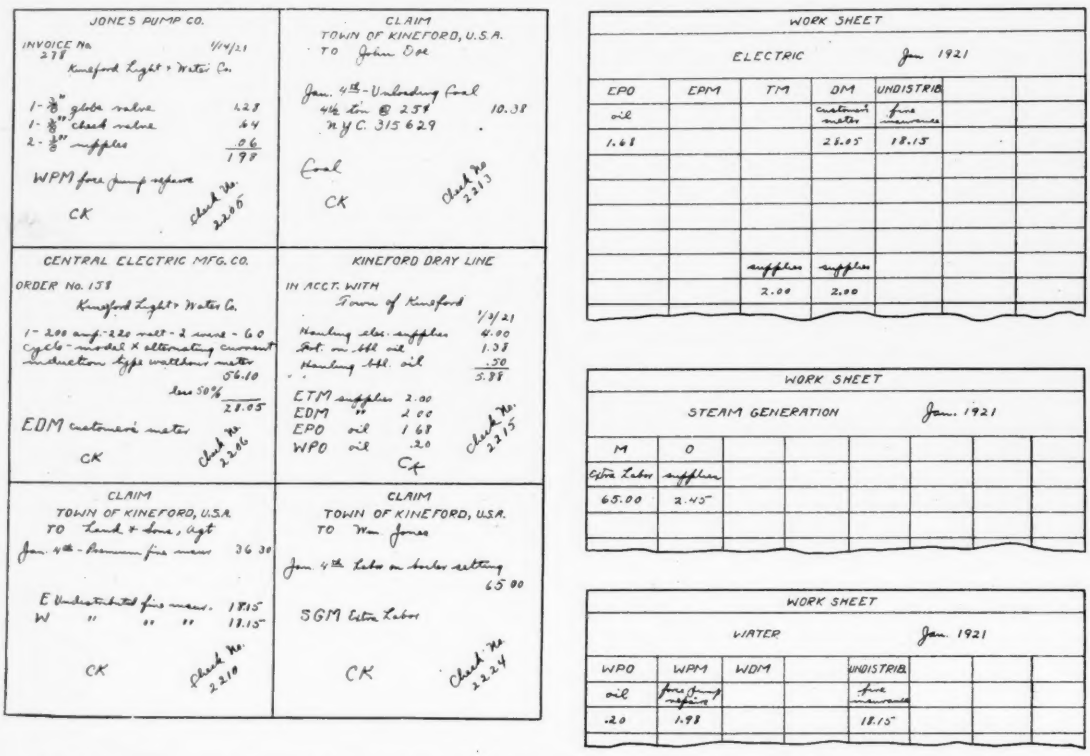


FIG. 6. METHOD OF MARKING BILLS OR CLAIMS AND MAKING DISTRIBUTION OF CHARGES TO WORK SHEETS

to cost sheets), an advantage which was explained before. Tom told me that it took him but 4 hr. to paste the December claims in the bill file, check their amounts against the voucher stubs, mark them with the green pencil, draw them off onto the work sheets, carry these totals to the proper columns on the various cost sheets, find his sub-sectional and sectional and grand total costs, find and set down his "totals to date" of each column, carry his "sectional" totals from the Electric and Water sheets to the recapitulation sheet and total the latter.

This time of 4 hr. did not include the income statements as the treasurer did not have the items ready at that time. Four hours for a month's records and the heaviest month for claims at that. Tom had one advantage. He knew where to distribute the items of expense without asking anyone.

five; 4½ hr. of work, and he had forms good for one year's records. Of course it would be better to buy these sheets in book form, should they ever be printed. For, no doubt, each book would contain several copies of the same form; the forms would be more neatly gotten up; and they would be more easily stored, carried and examined, besides being more permanent. Yet 4½ hr. work is no excuse for failure to keep a cost accounting system—no, nor 10 hr. work, for that matter.

This is Kineford's system of cost accounting on its light and water plant. A request from the State Commission forced the Town Board to adopt it, but it would take a court order to make them relinquish it. If this story of Tom's system aids you in working out a system of accounting for your business, then I shall be pleased that I took the trouble to tell you about it.

Flour Making by Oil

WHY OIL ENGINE POWER WAS CHOSEN FOR A FLOUR MILL AND SOME COSTS OF OPERATION. BY ALBERT L. COPELAND

USUALLY a power unit is chosen for its power rating, adaptability, flexibility, cost of installation and operation, and on this basis oil engines are growing in favor. Diesel, semi-Diesel and other types of internal combustion engines have passed the experimental stage long ago and each type now follows certain well defined principles of construction and operation.

Certain industries, flour mills among them, require prime movers of great flexibility and smoothness of operation. Among mill men, there is an idea that a water-driven flour mill produces a superior grade of flour which is on account of the steadiness of running; that the oil engine has come into favor for such work is as good a proof as could be furnished of the reliability and steadiness of such plants.

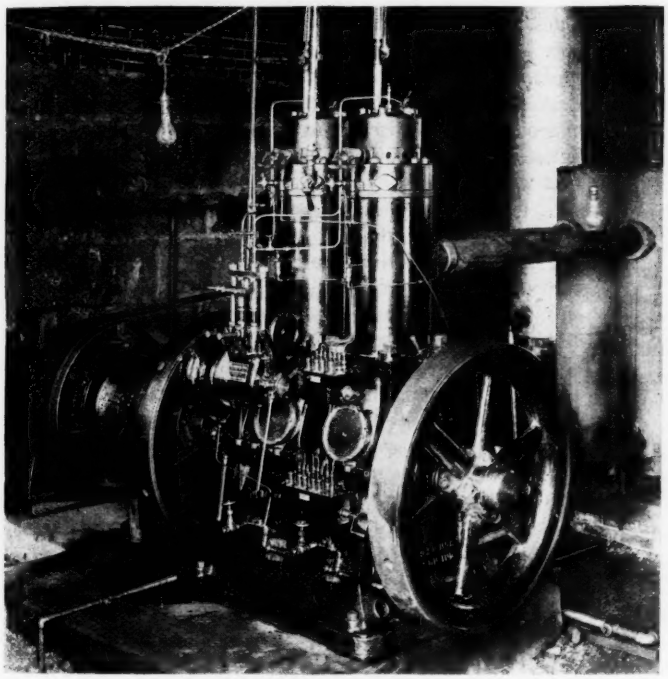


FIG. 1. SEMI-DIESEL OIL ENGINE IN THE PLANT OF THE SPRINGS VALLEY MILLING CO. AT FRENCH LICK, IND.

In January, 1921, the Springs Valley Milling Co. of French Lick, Ind., was faced with the necessity of some overhauling of its power plant. It had been operating with a steam plant, was near good coal fields, and could continue such operation by renewing the boiler. After investigation, it was decided to install an oil engine, and a two-cylinder, two-cycle, 60-hp. Anderson semi-Diesel equipment was chosen. The mill load is 40 hp., equipment including the usual machinery required for a small mill of 60 bbl. rating. It has four stands of double rolls, a three-high corn roll, two separators, two scourers, two reels, two dusters, a purifier, a pulverizer, a corn sheller and a 12-in. buhr mill.

The engine has operated on fuel oil, gas oil, distillate and kerosene, the latter now being used. This costs 6.78 cents a gallon in tank cars, and is stored in tanks on the mill lot, being transferred to the supply tank as needed. Fuel consumption is 3 gal. per hour or at the rate of 0.6 pint per hp.-hr. The engine uses 2 gal. of lubricating oil of heavy type in 12 hr., the excess being filtered and reused. The cost of fuel and lubricating oil for a 12-hr. run is, at present prices, $3.44, or at the rate of 0.508 cent per hp.-hr. If the mill load were nearer to capacity, the economy would be ever better and the fuel consumption per hp.-hr. would be less. Kerosene is preferred as a fuel since it makes a more perfect fuel than the heavier oils, and the better operation more than pays for any slightly greater cost.

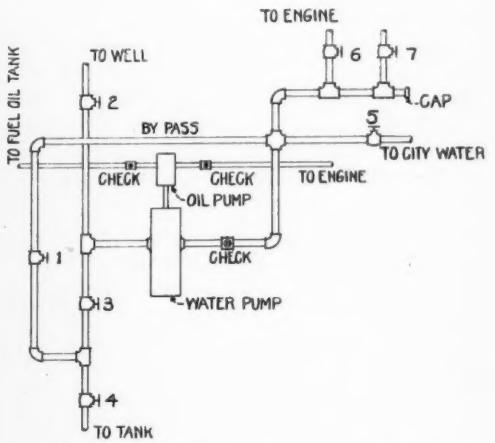


FIG. 2. ARRANGEMENTS OF PIPING FOR WATER AND FUEL PUMPS

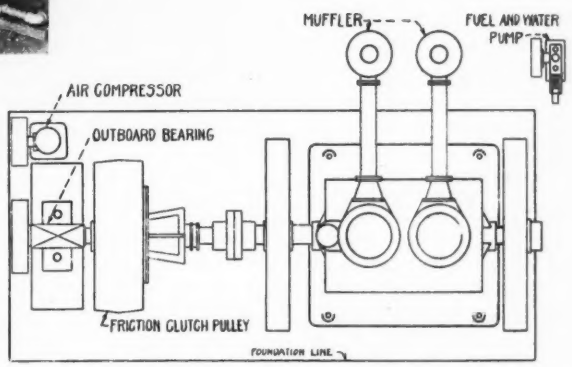


FIG. 3. PLAN OF ENGINE, CLUTCH, COMPRESSOR AND PUMPS

Cost of attendance is reduced over that of a steam plant, as the engineer finds considerable time to assist in the mill and elevator when not occupied in the engine room. Also in case the engineer is absent, there are three other men in the force who can operate the engine.

Water for cooling is taken from either the city main or a well on the premises. The arrangement of piping

is as shown on Fig. 2, excess of water being delivered to a 40-bbl. tank from which water is taken when it is filled. Enough water is used to keep the temperature of the outlet at 140 deg. F., flow of water being regulated by valves 6, 7 and the bypass 1 so as to give the temperature for best operation. City water when used goes direct to the engine; well water may be pumped to the engine or to the tank; and tank water may be used direct on the engine or pumped through, alone or in connection with well water.

Arrangement of the engine is shown in Fig. 3, a single concrete foundation, 87 by 54 in. and 36 in. deep serving the engine, outboard bearing and compressor. The engine runs at 300 r.p.m., driving, through the clutch shown, a 36-in. pulley, from which a belt drives the line shaft at 150 r.p.m. The air compressor is used to provide starting air at 200 lb. pressure, stored in a tank at one side. Ignition for starting is secured by heating the firing pins with fixed torches which use a mixture of kerosene and gasoline. It takes but a few minutes to heat the pins, and one quick opening of the air throttle gives a start as ready as that of an automobile motor.

Efficient but economical lubrication is an important item in the operation of an oil engine. When the engine was new, an excess of oil was used; but as soon as bearings were well worn in, the quantity was much reduced. An expert from one of the oil companies made a careful test and study of the plant and gave much valuable advice, this service being gratis. He studied not only the lubrication, but the relation of temperatures of the engine to economical operation, and his findings reviewed by an expert from another company, were found good.

Combined oil and water pumps are driven from the engine by a belt. Should the belt break and stop the water supply, the engine would stop for lack of fuel before overheating could occur. The fuel oil is pumped from a supply tank located 80 ft. from the mill, a 1-gal. tank at the engine being kept filled, and the excess oil returned to the line through a bypass.

Mufflers are set in the engine room above the floor, the heat not being found oppressive in summer, and serving to warm the room in winter.

This is the second installation of oil engines by this company in its flour mill plants, and there is no doubt that when another prime mover is required, it will be an oil engine. During the past year, power costs have been low, repairs practically nothing, troubles none. We feel that for a flour mill a good oil engine gives power which is satisfactory both as to quality and cost.

This method was used in December of 1919 in a large industrial plant for an initial study for power factor conditions on all feeders from the power house. The very interesting and instructive results obtained through this study lead to the consideration of synchronous motors for all future installations where the application would permit this type of apparatus.

NEW PLANTS and extensions in Formosa, Japan, amount to a capacity of 119,400 kw. The largest company at present has capacity of 14,525 kw. and capital of $15,000,000. Its present lighting load is 243,551 lamps and addition of 111,000 kw. is planned.

Curing Static Electricity in an Oil Engine Plant

By W. L. HOLDEN

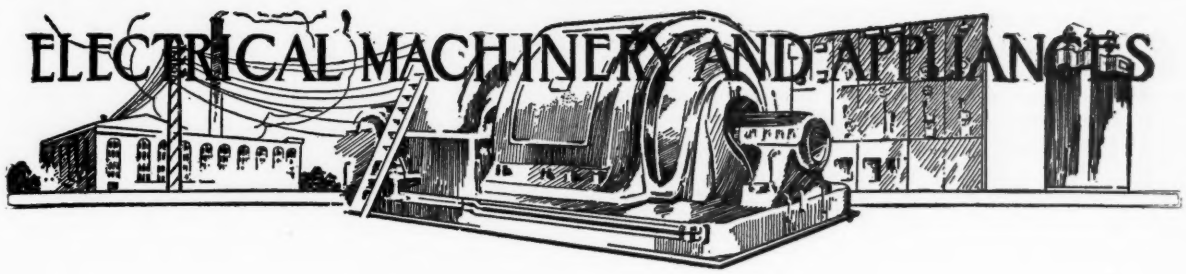
WHEN I took charge of the power plant owned by the city of Peetz, Colo., on Sept. 10, 1920, it consisted of one unit, a type Y Fairbanks Morse oil engine driving a 15-kv.a. General Electric, a.c. self contained generator by means of a 45-ft. single thick belt. The generator was a three-phase machine, but had always been operated with only a single phase, the five transformers being located at various places about the town, but all connected in parallel. When any load was thrown on, even so much as the Monday wash or the Tuesday flatiron, the voltage would drop to zero and stay there until the main switch was pulled, the voltage built up and the switch thrown back in. The result was that the sudden load thrown on the generator would cause the belt to slip on the generator pulley burning the belt, and this would happen no matter how tight the belt was stretched.

Under these conditions the static charge was so strong that it would jump to you at 8 to 10 in. from the belt, a condition that it was highly desirable to remedy. Two pieces of ¾-in. pipe were driven into the ground about 4 ft. at 18 in. from the generator pulley so that the belt cleared them by about 1½ in. on each side. I then put unions on the ends of the pipes and connected across above the belt. Next the belt was treated with a good grade of belt dressing and slacked off so that there was about 18 in. sag at ¾ load. The third brush was dropped in on the generator so as to operate three phase as it should have been in the first place. The result was that the generator never dropped her load and there was no further trace of any static electricity to bother us.

Since I came here we have bought and installed another unit, an Anderson three-cylinder, 60-hp. oil engine, direct connected to a 48-kv.a. General Electric three-phase generator running at 2300 v. This unit is used to pull the peak load, while the small unit handles the day load which usually runs from 6 to 8 kw., and the pumping system which calls for 7 hp.; the peak runs from 21 to 25 kw. with the pumping in addition, which is more than the smaller unit can carry. Formerly we used kerosene for fuel, but now that we have a large tank installed we are using distillate of 36 to 38 deg. Beaumé. On test the small unit gave 0.65 lb. of oil per hp.-hr. and the larger one 0.52 lb.

We are using a medium tractor oil for lubrication having a castor oil mixture and have a filtering system which permits re-use until the oil is all gone. There is no waste, as all the heavier oils that come from the filters are cut down with thinner oil and dumped into the fuel tank for use in the Anderson engine.

TEST RUNS have been made by J. D. Davis and J. F. Byrne at the Pittsburgh, Pa., experiment station of the Bureau of Mines to determine the relative tendencies to spontaneous combustion of different parts of the Freeport coal seam, the critical temperatures being 185, 190 and 207 deg. C. The coal below the floor is very rich in anthraxylon and runs 4.4 per cent sulphur, of which 3 per cent is pyrite and marcasite.



Commutator Trouble

HIGH BRUSH TENSION AND LOOSE PULLEY CAUSED VICIOUS SPARKING AND UNSTEADY VOLTAGE. BY R. A. CULTRA

FIGURE 1 illustrates an armature with a loose pulley and grooves worn in the commutator under the brushes. The machine had given much trouble from sparking at the brushes and the mica was under cut in the belief that hard high mica was the cause of the sparking. After the job was completed the commutator was sandpapered smooth, brushes well fitted and the machine ran a few days with little sparking; the job did not eliminate the sparking entirely. The brushes would become stuck in the holders from dust and had to be cleaned out at frequent intervals. So the machine was given a sand-papering each time the brush holders had to be cleaned. During the war period it could not be spared to test it out, as it was used about 15 hr. out of the 24-hr. day.

An accident happened one day which caused the engine to race and the dynamo, being a high-speed belted machine, greatly exceeded its speed, though this did not seem to cause any increase in the sparking of the brushes afterward. It was noticed a few days later that there were several loose lead wires where soldered to the commutator bars. Equipment for soldering these loose leads back properly was not available in the plant and the machine was nursed along until after the armistice, and the night work had ceased. The sparking had increased and the commutator would run hot, heating up the bearing so the oil had to be changed and a mixture of cylinder and machine oil was used to keep it cool. When the factories were all running two or three days per week, the job of resoldering the armature lead wires to the commutator bars was given to a local electrical repair shop with free reign to put the machine in perfect working order, as it had gone its limit. They soldered the lead wires in and turned down the commutator, but left a lathe tool finish instead of a polish on the surface, and instead of putting on a new set of brushes put on the old ones which were hard carbon soaked in cylinder oil, and supposed to be very good, but the heat from the commutator previously sparking had burned all the lubrication out of the old brushes. They were put on and great care taken to run sandpaper under them to have them fit the curve of the surface of the commutator and to make sure they did not stick in the box brush holders. Plenty of tension was put on the spring S (see Fig. 3) and the nut T, screwed down on the bolt B until the spring bent down as shown at J. The pulley was of paper with iron hub, with the usual key slot, but the set screws to hold the key were only accessible by inserting a screwdriver in the holes in the paper rim face as at S, Fig. 1.

When the machine had been dismantled to take the armature to the shop, the pulley was found to be rusted to the shaft and was drawn off at the shop. When the machine was reassembled and the pulley put

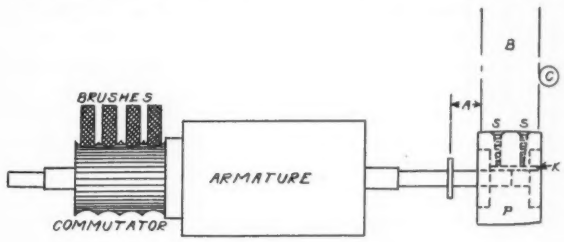


FIG. 1

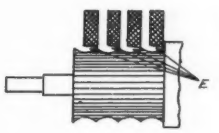


FIG. 2

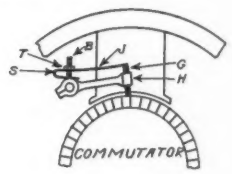


FIG. 3

FIG. 1. LOOSE PULLEY FORCES ARMATURE IN DIRECTION SHOWN BY ARROW

FIG. 2. BRUSHES RIDE ON SHOULDERS BETWEEN GROOVES IN COMMUTATOR

FIG. 3. POLE PIECE, BRUSH AND HOLDER IN PROPER RELATIVE POSITIONS

back on the shaft, the set screws S were driven only hand-tight with a screwdriver instead of putting a wrench on the screwdriver and turning the set screws up tight enough to hold them and the key in place. The machine was started after the belt B was put on and tightened up. It ran well for about a week, then sparking commenced slightly at the brushes, and this sparking steadily increased during the next week until at the end of the third week the man who had done the work was sent for. He looked the machine all over while it was running. The commutator was fearfully hot and cut and smoked and grooved as Fig. 1 shows, the brushes resting in the grooves and shoulders between the brushes. The shaft had a very slight end thrust in the past, but there was none noticeable at this time. These grooves had been ground into the commutator in three weeks' time by the excess tension put on the brushes.

The man seemed at a loss to account for this con-

dition and recommended the commutator be smoothed up with a piece of sandstone. This required the engine to be run overtime and the job had already been an excessive expense and it was then learned that they had no carbon brushes at their shop and had not ordered any. He was not engaged to do the job a second time.

While looking the machine over while it was running, I heard a peculiar sound of the belt as it passed over the pulley and noticed that the belt rubbed against an iron rail post, at C, Fig. 1, leaving a space as at A between the belt and the bearing. The rattle and buzzing sound so startled me that I thought the belt was running off the pulley from being out of alinement. But the next instant it went back to the line A and all was quiet. The commutator was hardly sparking. Then a flash and many sparkings. The belt was against the post again and the pulley P with it. After a minute it again returned to the line A. I then noticed that the key K was protruding out of the hub about 2 in.

The machine was stopped, the pulley driven back with a sledge hammer, and the key driven in flush. One set screw had loosened up, leaving only the other to hold the key and the pulley had rocked on this one until it was somewhat loose, but held the key on the point after it had passed out from beneath the other set screw and protruded 2 in. beyond the hub. The pulley would slide off until the belt struck the post C with sufficient force to crowd the pulley back again as it wabbled and caused the buzzing roar which had startled me at first.

This action of the belt and pulley caused constant end thrust of the shaft and this end thrust forced the shoulders under the commutator brushes, lifting them up from the commutator as at E E E E in Fig. 2, making a very poor contact and causing the intermittent flashes, burning and sparking of the brushes to such an extent the voltage dropped at times down from 115 v. to 90 v. Too much tension on the brushes caused the old brushes to cut into the commutator quickly on account of the rough lathe tool finish, leaving the shoulders or ridge and lack of precaution to see that the set screws in the pulley were set up tight enough to hold, caused the intermittent end thrust which caused the brushes to rise and flash and spark. I ground down the commutator, put on a new set of brushes, fitted them to the curve of the commutator and set the springs with just enough tension to insure a good contact. The pulley had been driven back on the shaft to the line A and I tightened up both set screws with a monkey wrench on the screwdriver blade. The machine has run many months since with no trouble from sparking of the brushes.

In Fig. 3, F is the field frame, P the pole piece, C the commutator, D the brush holder post, H the box brush holder, and Z the point of the carbon brush, which is set on the line G in the plane through the center of the pole field. If brushes are properly set, none of the troubles described above are encountered and the machine sparks at full load or light load, it is usually because the brushes are not in the proper advancement for the extreme variation in the load.

When setting the brush holder H care must be taken to have all the holders on each holder post on the same level across the commutator and all sets of holders the same distance from the commutator to insure the brushes striking and bearing on the surface at the same angle; this also serves to eliminate sparking at the brushes; also the brushes should not be allowed to wear so short as to allow the spring S to rest on the top of the holder at H as there is no tension on the brush except to insure a good electric contact on the surface of the commutator. Often some lubricant such as a commutator compound or paraffin oil may be rubbed on the commutator to prevent wear and cutting, preserving a smooth glazed surface.

Power Possibilities in Rural Lines

Problems to Be Solved in Attempting to Serve the Farmer Are of a Special Nature

DUE LARGELY to the establishment of rural mail delivery, the advent of the telephone and later the automobile and paved roads, the farm is daily coming closer to the city. Primarily for this reason the farmer has ceased to be content with the things that were good enough for father or to believe that just because he lives in the country and away from things he must deny himself such comforts, conveniences, and necessities which are available to his brother in the city.

He no longer has to hitch up and drive to the village postoffice for his mail and the weekly newspaper; he now has the rural delivery. He doesn't have to take a day off to go to town through the mire to set in a week's supply of food; he now has his auto and there is a good road to drive on. He doesn't have to isolate himself from mankind; he now has his telephone.

One of the most important and necessary of the agencies assisting in this development is electricity. No longer is it necessary to live in the city to enjoy its advantages. The farmer has come to appreciate its possibilities for helping him in his work. People living in outlying districts both need and want this service and are ready to pay for it. They want to avail themselves of the use of electrical conveniences.

This attitude has in the past and will undoubtedly in the future create a demand for a reliable isolated plant of ample capacity to take care of household lighting and a few other conveniences. These plants have been on the market for a sufficient length of time and in general use in such numbers that the rural public has been aroused to the potentialities of electrical service. It has been educated in the uses of electrical energy by these plants and is now demanding a better service, a wider application, and is calling on the central station. The field of these isolated plants is inherently limited, but they have accomplished their purpose satisfactorily and will probably continue to serve. The pioneer work done by these plants has been infinitely valuable to all concerned for which the central station interests should be and are deeply indebted.

There are plenty of reasons why the farmer needs electricity and still more reasons why the urban population should want him to have it. The great majority of farmers can afford this service, in fact, they can not

afford not to have it. On the other hand, city people can ill afford to withhold from the farmer any service that will tend to reduce his cost of production, or that will make his life more worth living.

In the past, central station operators have, as a rule, been prone to fight shy of the rural customer because he has been considered unprofitable. He has tried to render rural service on the same basis as urban service and it has not paid. The difficulty has been in the question of rate fixing but all that is being changed. Where higher rates have been charged to this class of customer they have felt that they were being discriminated against, but where they have been informed as to the difficulties under which this service must be given they have been willing to come half way and submit to the higher costs.

Applications

There are many ways in which electricity may be used to advantage on the modern farm, and it should be realized that most of these applications must be made if the service is to be had at anything like a reasonable cost. It will undoubtedly require considerable time before the farmer can arrange to utilize electric power to its greatest advantage, but as soon as the practicability of the electric drive has been demonstrated, it will not be long before most of the small and medium sized stationary farm machinery will be driven by electric motors.

With rural electric service in its present stage of development, the indications are that such machinery as threshers, ensilage cutters, wood saws, feed grinders, hay balers, etc., requiring motors larger than say 5 hp. capacity, can be more satisfactorily driven by other means such as the gasoline or kerosene engine. There are problems of an engineering nature which enter into the use of the larger capacity motors, and, until the farmer has become more used to the service and educated in the use of these larger units, arrangements to make use of them should be undertaken with caution.

The question of the application of electrical power to agricultural field work is debatable. Some experimenting has been done along this line in Europe, but the odds are against it at the present time. The horse and the gasoline tractor still monopolize that field.

Finance and Methods

The great obstacle that has had and will have to be overcome in supplying rural service is the question of finance and method of rendering the service. In the past many central station managers have failed to reach the farmer largely because they were working under the impression that this class of service must be furnished under conditions usually obtaining in the thickly populated districts. They have attempted to finance the whole proposition and to assume all risks in fixing rates. Experience generally has demonstrated the fact that these rates have been too low to yield a fair net return on the investment and consequently there has been dissatisfaction on the part of the power company with this class of service.

There are now, however, three fairly well defined plans that are being used with success in certain sections of the country. The first of these is where a group of farmers organize and build, own and maintain a line and buy their power on a wholesale basis from the power company. They thus assume all line and transformer losses and repair costs. In this way the overhead charge and current costs are kept separate with the result that the cost of the current is reduced. The disadvantage of this system lies in the fact that maintenance is likely not to receive the care that it should and consequently there is more chance for interruption of service. In some cases the power company is given an option on the line, in which case it should be allowed to supervise the construction and maintenance.

The second is where the farmers build the line, but as soon as it is built the ownership passes to the power company as compensation for maintenance and the assumption of line and transformer losses.

The third system is where the power company builds and owns the line and retails to the consumer in much the same way that it handles its urban load, with the exception that a higher rate is charged. Each of these methods has certain advantages as well as disadvantages and merits careful consideration. The plan finally adopted should not be decided upon solely by either party concerned, but should be the result of an agreement between the producer and the consumer.

Appreciating the problem to be solved in this connection the National Electric Light Association recently appointed a rural lines committee to study the situation. Seven sub-committees were formed to study the various phases: General rules, standards of construction, maintenance and operating costs, rates, methods of financing, utilization of the service, and development of farm equipment suitable for electric drive. A report of this committee presented at the recent meeting of the association throws some light on the matter of financing and maintenance. A review of the different methods employed in various localities is given and the good and bad points discussed. Essentially they are similar to the methods just described.

Selection of Voltage

The selection of the proper voltage for rural lines raises an important question. For such service, several different voltages are being used but 2300, 4400, 6600, and as high as 13,200 are being looked upon with favor at the present time. In some cases farmers are being served directly from the transmission lines which run between towns, but this practice is not general and is ordinarily looked upon with disfavor. There are also a few instances where farms located close to city limits are reached with extensions from the city line that carry a voltage of less than 2300, but these lines are short and their usefulness is limited.

Experience indicates that rural service should be given from lines built especially for that purpose. It is objectionable to tap onto high voltage transmission lines because transformers and protective devices are more expensive and also because conditions may develop at any one of these taps which put the line out of order and interrupt service for a whole community.

The objections to using less than 2300 v. is that the line is limited to about 3 mi. in length and no extensions can be made without using very large wire which is usually prohibitive from the standpoint of cost.

The selection between the limits mentioned depends on the number of customers to be served, the amount of power which each expects to use and the ultimate length

of the line. With a loading of about four farms per mile, a 2300 v. line should not exceed 6 or 7 mi. in length. For a longer line, 6600 v. is recommended.

When a voltage is decided upon for a line it should take into account all future demands for service. It is not practical, for instance, to start a line on 2300 v. with the intention of raising the voltage as the load increases. This would mean that all transformers and protective devices along the line would have to be replaced at a prohibitive cost.

Voltages above 13,200 are not to be recommended on account of the fact that small power transformers are not efficient for such large drops and because the initial cost is unreasonable.

When lines are installed in an undeveloped region frequently only a single tap is taken off the station transformer so as to give single phase service. Later as the load grows the second and third phase lines are run out without much additional expense. There are several types of system that may be used: Single phase grounded and single phase metallic. These are properly applicable only to short extension. The grounded system interferes seriously with telephone lines and is consequently unpopular. The three-phase, four-wire system is borrowed from transmission practice but for the lower voltages it presents a needless complication. The three-wire, three-phase is preferred in some places because it imposes less severe strains on the fuses, oil switches and lightning arresters.

Sub-Stations

Probably of more importance than the voltage or type of system is the farmer's sub-station. Continuity of service is an important feature of central station operation and for this reason special care is usually taken in installing a sub-station to prevent local trouble from interrupting service on the whole line.

Such a sub-station must, besides being inexpensive, have an ample factor of safety and must have full switching, lighting protection and overload protecting features. In case of trouble it should disconnect at once from the line so as to localize the disturbance. It should be absolutely safe and should have as little wiring as possible and should be so arranged that when the main switch is open all equipment is readily accessible. Neatness, while it is not strictly an engineering consideration is important. These sub-stations can be and are frequently mounted on a line pole nearest the farmer's load. A primary switch should be so arranged that it can be opened or closed from the ground.

Metering is usually done on the secondary side, the meter being located on the farmer's property. In some cases, however, depending on the basis on which current is bought, metering is done on the high side through the aid of a current transformer.

Transformers

The proper size of transformer to install is a question which should be given careful consideration. If only lights, household appliances and small motors are used the transformer should not ordinarily be more than 1 kv.a. on a 2300-v. line or 1½ kv.a. on a 6600-v. line (1½ kv.a. being the smallest standard size for this voltage). If larger motors are used or if current is used for cooking, a larger unit may be necessary. Ordinarily it is best to install a transformer of a capacity sufficient to take care of the normal load, as a 50 per cent overload can be safely handled for a period of several hours.

Transformers operate at low efficiency when lightly loaded and it is therefore desirable that a size be used that will avoid this condition. The core loss goes on all the time whether current is being used or not, and it is desirable to use as small a transformer as possible to reduce this loss to a minimum. For instance in a 2300-v., 60-cycle, 1-kv.a. transformer, there is a loss of about 20 watts or 14.4 kw.-hr. per month which may amount to a large percentage of the total power used when the demand is light. Lightly loaded transformers result in an extremely low power factor and if there are many of them on a given line, conditions may become so adverse that it is impossible to give good service. Transformer core losses should be kept at as low a figure as possible even at the expense of increased copper losses. Even though this will reduce the full load efficiency the 24 hr. efficiency will be improved and it is this efficiency of course that counts in figuring the net profits.

There seems to be no question now-a-days as to the desirability of electric power on the farm. Besides the more common adaptations such as lighting, cooking, washing, ironing, cleaning, and general power, it has recently been applied to advantage in the dairy.

In one plant that recently came to our attention the operator has to figure on what he calls a flat iron load just as he figures on the street railway peaks during rush hours or the industrial peak. His flat iron peak often requires that he put an extra machine on the line. This load he is able to predict with a certain degree of accuracy, for instance, if Monday is a bright day so that washing can be done, he prepares for his ironing load at about 9 o'clock the next morning. If it is dark and raining on Monday this load does not occur on Tuesday but on the day following the next bright one.

As an indication of the growth of rural service, one public utility of Wisconsin reports that in spite of the business depression during the last few years and the consequent falling off of the industrial load, the total output of their plants has been steadily increasing due to the increase in consumption in the home both in the cities and in the rural districts.

An investigation regarding the heat of distillation of coal is being conducted at the Pittsburgh, Pa., experiment station of the Bureau of Mines. This investigation has for its object the determination of the amount of heat evolved or absorbed through chemical reaction during the process of destructive distillation of coal. Such information will be of value to the by-product coking and gas industries in that it will give them a more accurate knowledge of the thermal requirements of their ovens and retorts. The problem is being attacked by distilling small amounts of coal in a bomb calorimeter, the necessary energy being supplied electrically and being accurately measured by electrical means. The heat effect of the standardized amount of electrical energy required to distill the coal is measured in the calorimeter and compared with the effect of the same amount of energy supplied to the products of distillation in the calorimeter during a parallel experiment. The difference between the two effects gives the reaction heat of the coal, positive or negative as the case may be.

Determining Power Factor With Two Watthour Meters

A Simple Method of Power Factor Determination Suitable for Use in Industrial Plants. By L. P. Staubitz

THE IMPORTANCE of power factor study in industrial plants is gradually being admitted. In plants where the generating capacity is limited or in cases where it becomes necessary to operate an additional unit in order not to exceed the kv.a. rating of the generator carrying the load, the influence of the system power factor cannot be overlooked. In the latter case, if it is possible to improve the power factor, the starting of the extra unit may be delayed with a consequent increase in economy of operating. A low power factor causes a reduction in the kilowatt rating of the generator, necessitates increased exciter capacity, causes increased heating of the transmission system for a given kilowatt transmitted and produces undesirable effects on the induction apparatus. It is therefore desirable to obtain information on the plant equipment to determine its effects on the plant's or system's power factor.

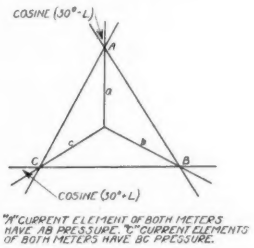


FIG. 1. SHOWING RELATION OF CURRENT AND PRESSURE IN A 3-PHASE CIRCUIT

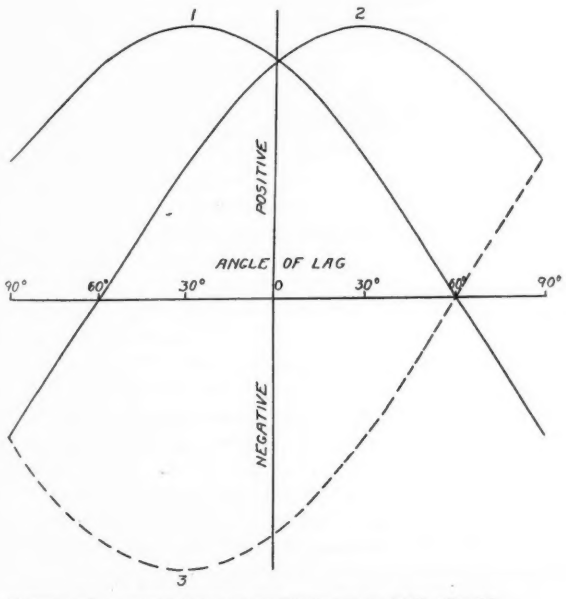


FIG. 2. SHOWING EFFECT OF VARIOUS POWER FACTORS ON THE TWO POLYPHASE METERS

The best method for power factor study is one in which the load as well as the power factor may be registered. The facilities provided by most industrial plants do not as a rule allow methods involving equipment not found in actual service in the plant. The following method requires nothing more than a spare polyphase watthour meter similar to the regular installation. In many instances, especially where the generated voltage is 2300, the potential transformers have no secondary half tap connections. This prevents the potential transformer connection method, and it was because of this fact that the following method was devised.

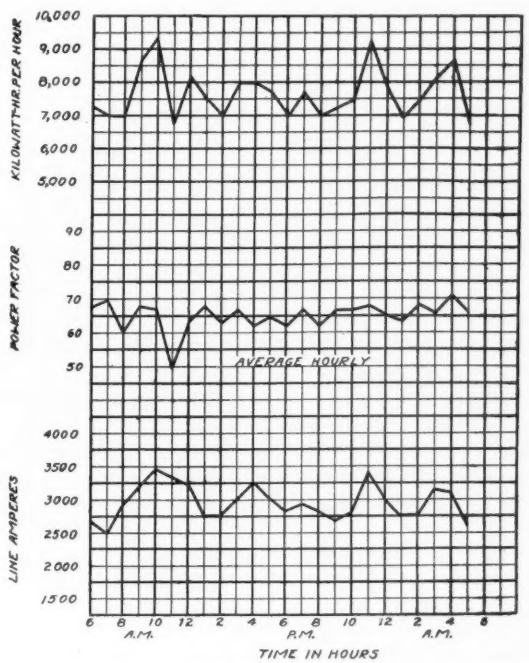


FIG. 3. POWER FACTOR AND LOAD CURVES OBTAINED BY THE USE OF TWO WATTHOUR METERS

Theory of Method

THE POWER measured in a polyphase circuit by a watthour meter is expressed by the following equation (see Fig. 1):

Power (as metered) = E I Cos. (30 — a) + E I Cos. (30 + a).

This reduces down to

Power = $\sqrt{3}$ E I Cos. a.....(1)

in which a is the angle expressing the phase difference between the current and voltage.

Now, if one current element of the meter is reversed, the sign of one part of the meter equation is also changed. The equation with one current element reversed, becomes

Meter registration = E I Cos. (30 — L) — E I Cos. (30 + L) = E I Sin. L.....(2)

The time for one revolution of the meter disk for a

given condition varies as the load, i. e., doubling the load reduces the time for one revolution one-half.

$$\text{Then } T_1 = \frac{1}{P_1}$$

$$\text{And } T_2 = \frac{1}{P_2}$$

Where P_1 = revolution of cosine meter
P_2 = revolution of sine meter
T_1 = time for P_1 revolutions of cosine meter
T_2 = time for P_2 revolutions of sine meter

$$\text{then } \frac{T_1}{T_2} = \frac{\frac{1}{P_1}}{\frac{1}{P_2}} = \frac{P_2}{P_1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Substituting 1 and 2 in 3.

$$\frac{E\ I \sin. L}{\sqrt{3}\ E\ I \cos. L} = \frac{T_1}{T_2}$$

which reduces to

$$\text{Tangent } L = \frac{\sqrt{3}\ T_1}{T_2}$$

Thus having one meter connected in the normal way to read the power component and one connected to read to reactive component, the tangent of the angle may be found and from the angle the cosine or power factor of the circuit. It is much more convenient to use the dial reading of the integrating watthour meters instead of timing the revolutions of the disks.

The formula then becomes

$$\text{Tangent } L = \frac{\sqrt{3} \times \text{reading of sine meter}}{\text{reading of cosine meter}}$$

Graphical Illustration of Method

The effect of this reversal of the meter element may be shown graphically. The relation of the two wattmeter elements of the normally connected meter under various power factor conditions are shown by the curves in Fig. 2. The dotted line represents the reversed

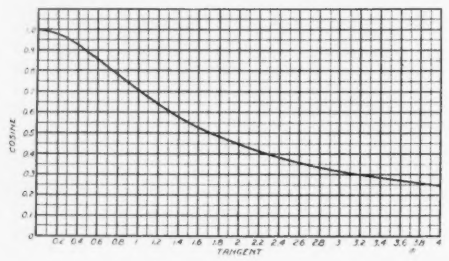


FIG. 4. COSINE-TANGENT CURVE

element. It is seen from these curves that at unity power factor (angle of lag zero) the torque of the two elements of the normally connected meter are equal and positive. The curves for the sine meter at unity power factor are equal but opposite in sign. Therefore the cosine meter is operating at its maximum speed, and the sine meter is stationary. At zero power factor (90 deg. angle), the curves of the cosine meter are equal, but opposite in sign, while the sine meter curves are equal and in the same direction. Thus the cosine meter is stationary and the sine meter is operating at full speed. At 60 deg. lag or 50 per cent power factor, the curves of one element of each meter pass through zero and only one element of each meter is effective. The two meters therefore operate at the same speed.

Installation of Meter

The spare meter can be mounted on a portable stand and taken to any point desired. The meter connection is shown in Fig. 5. The extra meter should first be connected correctly and the connection of one current element should be reversed. The correct element to reverse to give forward rotation of the disk must be

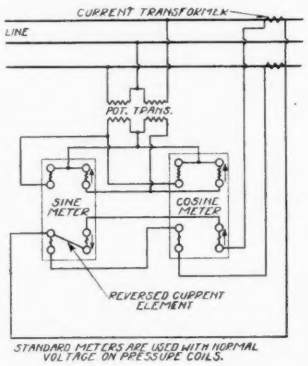


FIG. 5. CONNECTIONS OF COSINE AND SINE WATTHOUR METERS

obtained by trial. The readings of the two meters can be tabulated for any length of time and a curve of kilowatt input and power factor plotted on the same sheet as shown in Fig. 3. This gives a clear idea of the power factor variation with load conditions.

Considerable labor can be saved in calculating the power factor by the use of a cosine-tangent curve, such as is shown in Fig. 4, so that the cosine or power factor may be obtained by following the value of the tangent up vertically to the curve and then across horizontally to the value of cosine or power factor.

Adaptability and Accuracy of Method

One great advantage of this method is its simplicity. It does not require the running of additional pressure wires nor the special calibration of the sine meter, as this meter receives normal pressure on its pressure coils. It can be seen, however, that this method is subject to error on heavily unbalanced loads, i.e., where the three-phase line currents are not equal.

The load usually found in industrial plants consists of various sizes of induction motors, rotary converters, and three phase power transformers supplying three phase induction motors. With this class of load the three phase current is usually well balanced and the error of this method is small. Where the investigation is made to cover the penalties of a customer's power rate, the accuracy of the results with this method might be questioned unless the load conditions were known. For purposes of plant investigation, this method is sufficiently accurate and has much in its favor because of the ease in changing from place to place.

Bill Is Convinced

IN WHICH THE MYSTERY OF THE HOT GENERATOR PROVES NO MYSTERY AT ALL. BY A. W. KRAMER

WILL HARLOW, the cantankerous old chief engineer of the Hickory Products Co., was a graduate of the college of "Hard Knocks." The only degrees he had ever received were numerous degrees of hard labor. He was proud of his Alma Mater, however, and as a consequence possessed no use for slide rules and college men in general.

As may be expected, Bill was little inclined towards theory. He was essentially a practical man and during the 20 yr. he had had charge of the plant he had been able to keep it in good running condition, an accomplishment which was much to his credit, since he had to contend with much opposition from the management when anything in the nature of an improvement was suggested. They paid him for keeping the plant running, they told him, not for acting as purchasing agent. For 25 yr. the two old Corliss engines which served as prime movers had clanked side by side in spite of Bill's persistent attempts in later years to do away with them and substitute a turbine. Until the war had stimulated expansion and production, the management had remained obstinate, but finally by virtue of sheer necessity, had "come across" and after much persuasion and argumentation on Bill's part a 1700-kw. turbo-alternator had been installed. The management at first had favored the installation of a new and larger Corliss, basing their choice upon the fact that the old engines had given good service for nearly 25 yr. But the old chief had so bitterly opposed this plan that they had finally consented to buy the turbine. Bill had taken it upon himself to assume the responsibility for the successful operation of the new machinery; he had sufficient confidence in his convictions to do this. The management, on the other hand, predicted all sorts of dire disaster—the manager himself stated that the machine would probably blow up if left alone for five minutes.

But now trouble had developed. The generator in spite of its rating of 1700 kw. ran hot, persistently, on loads as low as 1600 kw. The first few weeks after installation the machine had operated like a charm and the management had seriously been considering congratulating the chief when the new factory load was put on and the heating commenced. Bill, of course, was the "goat."

This afternoon, Bill stood in the doorway to the engine room relating his troubles to Jimmie, the shipping clerk, who had come in to borrow a wrench.

"I know there ain't nuthin' wrong with the machine, Jimmie," he confided. "The whole trouble is, they got too many induction motors on the line, but the G. M. won't see that. He says the machine ought to run just as well with induction motors on the line as with circular saws or washin' machines."

"Well," inquired Jimmie, "what can you do about it? Shouldn't the turbine be able to handle the load if it is below its rated capacity?"

"I dunno," replied Bill, thoughtfully. "I should think it would, but yuh got t' figger this power factor business with it. I don't know much about power factor, but I know that a lot of induction motors will lower the power factor and that's not good for the machine. They say if yuh hook a synchronous motor on the line it will bring the power factor up, so I told that to the G. M. and asked him to get a synchronous motor, but he wouldn't listen t' me."

"What did he say?" asked the shipping clerk, interested.

"Oh, same old stuff, about the turbine bein' no good an' that we should have got a new Corliss. Said we spent enough money without buyin' a fool synchronous motor. Anyway, he says the machine was guaranteed to carry 1700 kw. at 85 per cent power factor and our power factor is 87 per cent. I know I ain't got much of an argument."

"Did you write to the manufacturers about the generator heating up? They should be able to tell you the cause of the trouble."

"Sure we did," replied the chief. "We opened the machine up and tested out the windings; but when we couldn't find nuthin' wrong, we put it together again an' writ a letter to the people that made it."

"Did they answer your letter?"

"Yeah, they cum back wid a letter tellin' us that maybe our load was unbalanced or that the power factor was wrong. They said the power factor should not be lower than 85 per cent."

"And that's where the joke was on them," put in the assistant, who had joined the conversation. "The power factor meter never registered lower than 87 per cent—2 per cent higher than they told us to keep it, and still the machine gets hot."

"Was your load balanced?" inquired Jimmie.

"Well, not exactly," admitted Bill, "but that shouldn't make so much difference. Anyway, we balanced it, but it didn't help any."

Just before the noon whistle the following day the generator had again heated up to such an extent that part of the load had to be taken off. Yet the recording wattmeter showed the highest load to have been 1570 kw., which was 130 kw. less than the machine's rated capacity. The power factor meter registered 87 per cent.

As a consequence of the trouble, the general manager had appeared on the scene, highly perturbed.

"What in the Sam Hill's the trouble now, Bill?" he demanded of the chief engineer. "I told you that this confounded concrete mixer wouldn't work. All your fool doing, too; if it hadn't been for your insistence upon getting this thing, we'd have a good old Corliss engine in here by this time. What's wrong with it?"

"Nuthin' I can see, Mr. Hinchman, except that she gits hot. I had to cut some of the load off."

"Hot, eh?" repeated the G. M. "Of course she gets hot—that's all its good for—for a radiator. How much load were you carrying?"

"Fifteen-hundred-and-seventy kilowatts," replied the chief.

"Well, she's supposed to carry 1700," snapped Hinchman, "and, by George, I'll make the manufacturers take the fool thing back!"

That afternoon when the load requirements in the plant had decreased and the turbine was again handling the reduced load satisfactorily, Bill sat in his cubby-hole of an office pondering over his troubles. He was not what might be called agreeably disposed.

His meditations were interrupted by the appearance of a smartly dressed young chap, who greeted him.

"Chief engineer?" he queried, pleasantly.

"Yep," answered Bill. "That's me. What kin I do fer yuh?"

"My name's Larkins," replied the visitor. "Larkins, of the Engineering Book Company. I'd like to interest you in our Stationary Engineer's Library, on which we are making a special offer by giving to each purchaser of a set of this excellent 10-in. slide rule——"

"Slide rule, eh," repeated Bill with contempt, interrupting the salesman's discourse. "Nuthin' doin', young feller, yuh cain't sell any o' them things here. An' what's more, don't try t' tell me yuh kin learn t' be an engineer out o' them books, because I know different——"

"But," began the salesman, but again he was cut short.

"No buts to it," said Bill. "Listen here, I've bin in this game goin' on forty years, and I always got along without a slide ruler, an' I didn't drop into the engine room through a skylight, either. I cum up frum the ground floor. Them there slide rulers may be all right fer them efficiency fellers wot's tryin' to push us old fellers out av a job, but I don't need none. Wot I use, young man, is a monkey wrench an'——"

"Yes, I know," interrupted Larkins, amused at Bill's vehemence, "you work with a monkey wrench, and let me assure you that this slide rule won't deprive you of the pleasure of doing so, but it may, with the aid of these books, show you how to get the most out of your plant. These books, as you say, will not teach anybody to become an engineer, but they will show an engineer how to become a better engineer, provided he's willing to read them. They will aid you in solving those little problems which are bound to arise in every plant."

"They will, will they?" queried the old chief, sarcastically. "Maybe they'll tell how t' git more power out av a turbine?"

"No, perhaps not," admitted the salesman, "but they may enable you to test whether you are getting all the power you should out of your turbine."

"That's jus' what I wuz waitin' fer yuh to say," declared Bill, triumphantly. "All right, young man, I've got a turbine in here that's actin' lazy-like. Now, if yuh kin show me from them books whut's wrong with her, I'll buy a set of 'em, blast me if I won't."

The salesman smiled. This was a new one on him, and he had serious doubts as to whether he could tell the old man anything about his turbine, but the chief's defiant attitude aroused his sporting nature so he resolved to take a chance. He had been a trouble shooter for an electrical manufacturing concern at one time, and knew something about diagnosing trouble.

"Very well," he said, "I'll take you up, but I don't promise anything. I'm not a turbine expert and know nothing of your troubles nor of your plant. I'll see what I can do. Tell me what's wrong."

Bill himself was more or less surprised at the young fellow's prompt acceptance of the proposition, but he was glad, at least, to have some one to whom he could relate his troubles, so he poured out the whole story.

"Yuh see," he concluded, "the G. M. wanted to get a new Corliss, but I talked him out of it in order to get this turbine; an' now I'm the goat. Now if yuh kin cum in tomorrow morning I'll show you the machine."

The following morning when Larkins arrived the generator was already quite hot, the load having been in the neighborhood of 1600 kw. all morning. The temperature indicator registered 85 deg. C.—a temperature considerably over the allowable rise.

While Larkins was examining the generator and the instruments, Hinchman, the general manager, happened along and, of course, wanted to know what was up.

After Bill had acquainted him with the object of Larkins' visit and after the formalities of introduction had been completed, he laughed sarcastically.

"You are wasting your time trying to fix that thing; it was never made to run. I'd keep away from it, if I were you, it's liable to blow up any minute. You can't trust those things."

"I'm not afraid of that," answered Larkins, smilingly, "but there's no doubt about there being something wrong. The machine's entirely too hot for the load it's carrying. When did this heating first occur?"

"When we first put on the new factory load. Wasn't that it, chief?" inquired the G. M., making sure.

"Yeah," replied Bill, "that was it."

"Of what did this load consist?"

"Why, motors, of course—motors and a few lights," answered Hinchman.

"Yes, I understand that, but what kind of motors—induction motors?"

"Sure, all induction motors."

"I see," said Larkins, thoughtfully, "and how much did that lower your power factor?"

"Power factor?" repeated the manager, perplexed. "I don't know. Do you know, Bill?" he asked.

"Didn't lower it any that I could see," replied Bill.

"Why, it must have," exclaimed Larkins. "You can't throw on a whole new induction motor load without having it affect the power factor of the system. Are you certain your power factor meter is O.K.?"

"Why of course it is; whenever I take the load off, the pointer comes back to zero—I've watched it often," explained the chief engineer.

Larkins laughed. Too often in his varied experience as engineer salesman, trouble shooter, etc., had he encountered cases of trouble where there was nothing wrong. It had taught him to accept nobody's word for anything.

"Well," he remarked, "there's evidently something rotten in the state of Denmark, so I'm going to find out what it is."

"What are you going to do?" inquired Hinchman, eying him suspiciously.

"Take some readings first. What's your voltmeter reading, chief?"

Carefully scrutinizing the voltmeter, the chief replied, "Twenty-three hundred, exactly."

"Amperage?"

"Six hundred forty-eight."

Jotting these figures down in a note book, Larkins then, much to Bill's dismay, pulled a slide rule from his pocket and proceeded to multiply the two figures

together. This gave him 1,490,000 w. Multiplying this result by $\sqrt{3}$ he obtained 2,580,000 as an answer. Immediately his face lighted up.

"Hm-m," he mused, "twenty-five eighty. Quite a high kv.a. load. Now, chief, what's your wattmeter reading?"

"Sixteen hundred kw.," read the chief.

"Sixteen hundred kw., eh " repeated Larkins, recording the figures. "Now we'll see what our power factor really is. Dividing the kilowatt reading by the kv.a. load, we get $\frac{1600}{2580}$ or 62 per cent. There, gentlemen, is your trouble. Your power factor, instead of being 87 per cent as your power factor indicator shows, is in reality only 62 per cent."

"But I don't understand," exclaimed the G. M. "How can that be?"

"Why, it simply indicates that your power factor indicator is off, and that instead of carrying 1850 kv.a. as you thought, you are carrying 2580 kv.a. The rating of this machine is 2000 kv.a. at 85 per cent power factor."

"Then there's nothing wrong with the machine?" queries the G. M., still perplexed.

"Absolutely nothing," replied Larkins. "The trouble is with your meter, not with the turbine."

"Well, I'll be d——d," exploded Bill. "I thought all along that we were carrying too many induction motors."

The G. M. said nothing. The slide rule man talked too convincingly for him to start any argument.

Subsequent examination of the meter substantiated Larkins' conclusions. The moving element had become disarranged so that when the pointer reached the 87 mark it would touch the stationary element, thereby preventing anything below 87 being indicated. After being properly adjusted it registered 62 per cent.

"You see," explained Larkins, "your induction motor load pulled down your power factor to a point entirely too low for economical operation. My advice is that you install a synchronous condenser so that you can bring the power factor back to about 85 per cent."

* * * *

That afternoon as Larkins was leaving with Bill's order for a set of books, a curious reader if he had been close enough to overhear the conversation, might have heard Bill anxiously repeat, "And don't forgit, Mr. Larkins, to be sure and send me one o' them slide rules, and the book tellin' how to work it."

All of which goes to show that sometimes you can teach even an old dog new tricks.

Crane Valves and Piping in Calumet Station

ATTENTION has been called to the erroneous statement made in the article describing the Calumet station published in the May 15 issue relative to the steam and water valves, that "Edward valves are used on practically all of the steam and water piping." It is found that Crane Co. furnished the piping, valves and fittings except the special valves mentioned in the article, much of the piping being of extreme thickness—¾ to 1 in.

Useful Pipe Chart

GRAPHIC MEANS FOR CALCULATING WATER PIPE PROBLEMS. BY W. F. SCHAPHORST

WE OFTEN want to know the velocity of flow through a pipe of given diameter, and, we want to know quickly. Or, we want to know the cubic feet of liquid or gas flowing through the pipe per minute, the gallons per minute, or the pounds of water per minute.

All of these quantities are dependent, of course, upon the size of the pipe and since pipe sizes vary, standard pipe not being exact in internal diameter and extra heavy pipe being different also, it is always necessary to search through tables and make lengthy calculations before arriving at the result; and then, after a result is arrived at, one is not certain that the answer is correct.

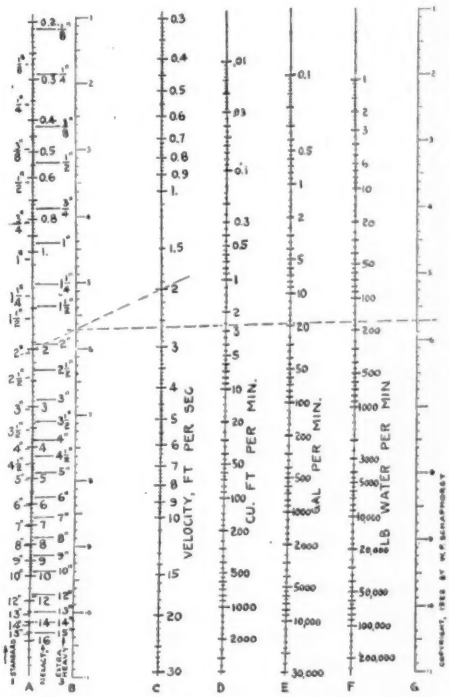


CHART FOR SOLVING WATER PIPE PROBLEMS

Here is a chart that takes care of all of these matters in a decidedly simple way. The best way to explain the use of the chart is to give a problem. First, it will be observed that there are three sets of figures given in connection with the left-hand column which I have called Column A. The left-hand column of figures, marked "No. 1, Standard," gives the actual internal diameters of standard pipe. This column shows, for example, that the internal diameter of a 1-in. standard pipe is somewhat greater than 1 in.

The column of figures marked "2 Exact," gives the exact diameter. Thus, if we have a pipe the internal diameter of which is exactly 2 in. as used in the problem which is cited below, we use this column of figures.

The right-hand column of figures marked "3 Extra Heavy" gives the actual internal diameters of extra heavy pipe. This column shows that the actual internal diameter of a 1-in. extra heavy pipe is less than 1 in.

For example, how much water is passing through a pipe, the internal diameter being exactly 2 in. and the velocity of the water being 2 ft. per sec.

Locate the 2 in Column A over the word "exact" and from its point of intersection run a straight line through the 2 ft. per sec. in Column C as shown by the dotted line. This straight line intersects Column B. From the point of intersection in Column B, run a straight line over to the similar point of Column G, also as shown by the dotted line. The intersection of this perfectly horizontal line from Column B to Column G gives answers simultaneously in three columns—Columns D, E and F. It shows that:

2.6 cu. ft. per min. are flowing through the pipe. (The correct amount is 2.615 cu. ft.)

A trifle over 19 gal. per min. are flowing through the pipe. (The correct amount is 19.58 gal.)

About 165 lb. of water per min. are flowing through the pipe. (The correct amount is 163 lb.)

This shows that the chart is very accurate, surely accurate enough for all practical purposes.

It is evident, now, on studying the chart, that if the pipe were a 2-in. "standard" pipe instead of exactly 2 in., the horizontal line from Column B to Column G would be slightly lower and three quantities would be slightly greater.

On the other hand it is also evident that if a 2-in. extra heavy pipe were used instead of the 2-in. exact, the horizontal line from Column B to Column G would be raised slightly above its present position and the three quantities would therefore be slightly less.

Inversely, if any quantity in Column D, E or F is known and it is desired to determine the velocity per second flowing through the pipe, this same chart can be used with equal ease. First run the horizontal line from Column B to Column G through the known point and then through the located intersection in Column B, run a straight line from the known pipe diameter and the intersection with Column C immediately gives the velocity in feet per second.

Or, if one wishes to select a pipe size, knowing any one of the quantities in D, E or F and having decided upon the velocity of flow, it is perfectly evident what to do.

At the same time it will be noted that this chart can conveniently be used as a conversion chart. For example, how many gallons in 2.6 cu. ft? The dotted horizontal line already drawn shows that the answer is slightly over 19 gal., which is also equivalent to about 165 lb. of water. At the same time this chart gives a visual demonstration of the relationship of pipe sizes—standard, exact, and extra heavy. By using this chart, one can quickly "read off" the correct internal diameter of a standard or extra heavy pipe.

The range of this chart has been made great enough to take care of almost any problem dealing with water, the standard pipe sizes ranging from $\frac{1}{8}$ to 15 in. and the velocities from 0.3 to 20 ft. per sec.

Should anybody prefer to use formulas rather than this chart either for solving the problem directly or for checking the results taken from the chart, here are the formulas on which the chart is based:

$Q = 2.45\ d^2\ v$

Where Q = gal. per min.;

d = internal diameter, in.;

v = velocity, ft. per sec.;

Cu. ft. per min. $= 0.327\ d^2\ v$;

Lb. water per min. $= 20.4\ d^2\ v$.

World Trade in Power Plant Material and Equipment

DECLINE is shown in both exports and imports of nearly all commodities for 1921 over 1920 by the statistics given on Our World Trade by the Foreign Commerce Department of the Chamber of Commerce of the United States; the average decrease in export value for all commodities was 45 per cent and in import value 52 per cent. For materials and equipment listed which are used in power plants, the decrease was much less than this average and in some cases even showed a gain.

From the tables given by the Chamber of Commerce, the values shown herewith have been selected and are nearly self explanatory. The value and quantity rank are those in the list of all commodities and the per cent total is that of the entire value of the exports or imports for the year.

It is hardly logical to compare the export business for 1921 with that for 1920 if it is desired to get an idea of the relation to normal; as in 1920 there was a huge and abnormal rise due to European demand and inflated prices. Comparison is also made, therefore, with prewar quantities for an average of 5 yr. from 1909 to 1913. On this basis, only copper and cement show a decrease in quantity exported, but the figures are not complete for manufactured machinery.

Such figures as are available seem to indicate that foreign trade in power plant materials and equipment was in better condition during 1921 than that in the average of commodities, and the fact that those figures show that the trade was greater than before the war warrants an optimistic attitude as to the future.

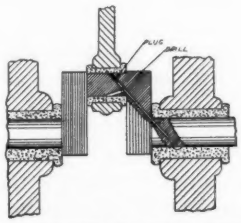
Commodity	Value			Quantity			
	Rank	Amount	Per cent Total	Rank	Change per cent 1921 from 1920	Change per cent 1921 from Pre-war	Per cent Production Exported
EXPORTS							
Coal & Coke	4	$170,982,000	3.9	1	−37.3	+41.9	5.8
Lubricating oil	9	92,697,000	2.12	9	−28.1	+55.1	41.0
Copper ingots, plates, wire, etc.	10	85,308,000	1.95	24	+ 8.0	−18.9	53.8
Iron pipes & fittings	16	56,219,000	1.28	19	+11.5	+82.9	....
Fuel & gas oil	20	45,973,000	1.05	4	+ 2.1	+135.4	14.4
Steam engines, boilers & parts	36	20,047,000	Under 1	..	.....	.....	....
Electric motors	48	15,444,000	Under 1	..	.....	.....	....
Pumps & pumping machinery	60	11,966,000	Under 1	..	.....	.....	....
Gasoline engines	71	8,764,000	Under 1	..	−73.1	+53.1	....
Insulated electric wire & cable	72	8,574,000	Under 1	..	.....	.....	....
Electric transformers	78	7,988,000	Under 1	..	.....	.....	....
Dynamos & generators	80	7,942,000	Under 1	..	.....	.....	....
Hydraulic cement	..	.....	....	28	−60.4	−57.4	3.9
IMPORTS							
Copper ingots, etc.	17	31,406,000	1.25	28	−32.9	− 9.7	....
Coal & coke	54	7,794,000	Under 1	..	.....	.....	....
Hydraulic cement	..	.....	....	75	−75.7	−44 2	....

Average decrease of all exports 1921 from 1920.....45%
Average decrease of all imports 1921 from 1920.....52%

Preventing Crank from Heating

On one of our auxiliary gas engines, the crank is oiled by means of a drilled crank; that is, a hole is drilled from near the center of one of the main crank case bearings through the throw of the crank and opened on the outside at the center of the crank bearing. It developed that this crank ran hot, although oil was being thrown from it which apparently showed that it could not be from this cause. The opening to the crankcase was at the front and made by removing a plate. This necessitated the crank standing in a forward, that is, an out position when adjustments were made. This seemed the ideal position because we reasoned that if the crank was worn out of round, it would be worn on the side where the thrust of the rod came when on the working stroke and thus by making the adjustment on the out center would be fitting the bearing to the largest diameter of the crank; but each time, on opening the case, the crank would be loose though there had not been sufficient operation to cause such if under normal conditions. The engine was of the high-speed type and had a rather heavy connecting rod.

Considering these conditions, we formed a theory and further examination led us to believe our theory was correct. On removing the cap of the rod from the crank, we found the cap and the outside of the crank to have plenty of lubricant, but that the inside of the crank, although not dry, did not have nearly so good a film of oil as the outside. We thus concluded that there were two direct reasons for the trouble. First, the centrifugal force of the crank and rod held the rod to the outside at all times with, of course, the exception of the in center and a short distance on either side;



OIL HOLE TO CRANKPIN

this would hold the rod close to the inside of the bearing. This same centrifugal force, which was the means of bringing the oil through the hole to the crank, also held the oil to the outside of the crank, all but what would by friction be carried around by the rod brasses, and this proved to be insufficient.

We determined to change the oiling outlet on the crank as an experiment and to do this we merely plugged up the end of the hole in the crank with a brass plug and drilled from a point just to one side of the inside of the crank so as to meet the other oil hole already through the crank. To do this we drilled with a ⅜-in. drill straight into the crank to a depth of ¼ in., then a 3/16-in. drill at an angle to meet the other hole. With this completed, the parts were reassembled and the engine placed in operation. We first trued up the crank, which was found to be flattened, and fitted the brasses perfectly by cutting off and reboring to fit. The continuous operation of the engine after the repair proved that our remedy was correct. Geo. G. McVicker.

Automatic Float Switch

I am enclosing a sketch of an automatic switch which I have in use in my plant for starting and stopping the motor which pumps water from the well to the water softener.

At first I used a toggle joint snap switch, but it didn't last long and as I needed something at once I

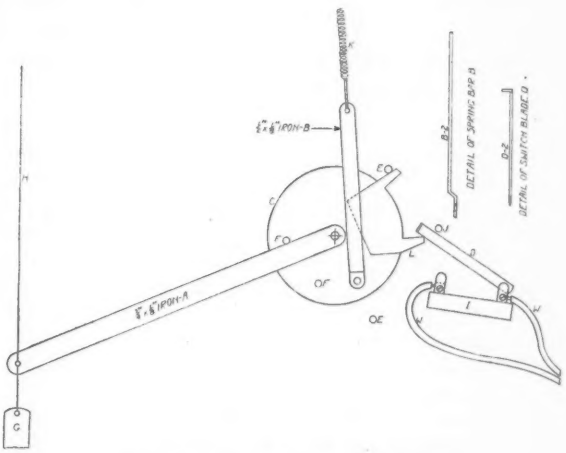


DIAGRAM OF AUTOMATIC FLOAT SWITCH

contrived this one and it does the work as well as anything you could ask for, and has never failed up to date.

Referring to the sketch, C is a hard rubber pump valve 4½ by ½ in., A is the shifting lever and is connected to a wire which in turn is connected to a float at the top of the water softener; B is a bar connected to a coil spring, as shown, which gives the mechanism the snappy action required in opening and closing any electric circuit. D is the bar of a small knife switch; E, F and J are stop pins for limiting the travel of the mechanism. The part indicated by L is made from a piece of 2 by ⅛-in. band iron and riveted to the hard rubber pump valve. W shows the wires connecting the switch to the magnet coils of the motor starter.

In the sketch, the switch is shown in the open position and the motor is at rest; when the water in the softener falls to a predetermined level, the float raises the lever A which bearing against the pin F turns the disk until the pin to which the spring bar B is connected passes the center; when this point is passed, a quick snap is given to the disk by the action of the spring K, causing the projection on the plate L to strike the switch bar D, closing it with a snap and starting the motor.

As the water rises in the softener, the weight G brings the shifting lever A down, which, resting against the stop pin F on the lower side turns the disk the opposite way until the pin to which the bar B is connected again passes over the center when the operation is reversed and the switch is opened.

The quick snappy action of the mechanism breaks the circuit almost instantly and there is no chance for the current to arc across the switch points.

The pin J keeps the switch bar from being thrown too far. B-2 and D-2 are detail sketches showing how these are bent; referring to D-2, it will be noted that there is a wide section for the projection on plate L to strike against, thus insuring positive operation as there is no chance for it to get by without hitting the switch bar.

The whole thing is mounted on a piece of plank and bolted to the wall.

There is nothing complicated about it and it is easily made of material found in every power plant.

Mine has been used for months and never failed, and requires no attention whatever except a drop of oil now and then. W. W. CARY.

Removing Scale by Heating and Cooling; Removing Oil from Belts

AFTER READING the operating suggestions for refrigerating plants by F. E. Matthews, in the March 15 number of Power Plant Engineering, it occurred to me that Mr. Matthews and other readers may not know about the successful way in which tubes are continually kept free from scale in the Lillie evaporator—a type of evaporator that is much used in the sugar industry.

Mr. Matthews advocates alternate heating and cooling of the condenser tubes, so that the tubes will alternately expand and contract, his theory being that the expansion and contraction will cause the scale to loosen and then fall off. The writer agrees with Mr. Matthews that the method should have some merits and would like to know whether or not any reader of Power Plant Engineering has ever successfully used this method.

The Lillie evaporator, as many may know, is a reversible process evaporator. It is so made that, say, in a six effect apparatus, either end may be the first effect and either end effect may be the sixth effect. Thus steam is first admitted into one end at a given pressure and temperature and it comes out of the other end at a lower pressure and temperature. After several days of operation, depending upon the amount of scaling matter contained in the liquor or water, the process is reversed. Steam is admitted into the "other" end, the tubes which were formerly comparatively cool are now warmer and as a result the scale does not form to a great depth. The scale is not entirely eliminated, but when operated properly the thickness of the scale should seldom if ever become greater than the thickness of an ordinary business card or "calling card."

In the March 15 number, H. A. Jahnke writes about an instance where sand was thrown on an oily belt and as a result the oil was mostly removed by absorption and thereafter the belt did not slip, due both to the removal of the oil and to the greater roughness of the belt.

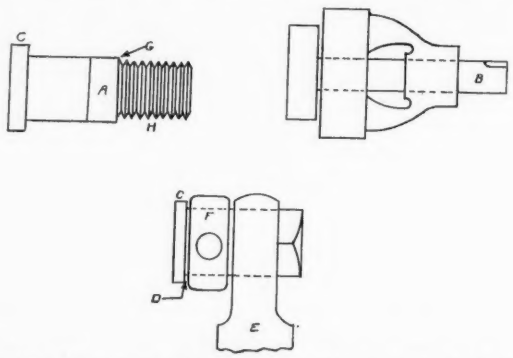
The writer does not doubt that sand will have the effect described by Mr. Jahnke. In fact, treatises on belts usually instruct us to use Fuller's earth on oil soaked belts. Fuller's earth is very good; however, in using it, or in using sand, it would be better to remove the belt from the pulley so as to keep these gritty materials out of the bearings. According to my way of looking at it, Mr. Jahnke is right in declaring that it was poor practice to allow the belt to become oil soaked in the first place. There is usually a remedy for spattering oil. N. G. NEAR.

Curing a Knock

A GENTLE KNOCK developed in one of our engines that as the day went on continually became louder. It was traced to the crank end exhaust valve, and it was decided to finish the run without stopping.

The exhaust radius rod was disconnected from the crank E, and the key holding the crank E on the valve stem pulled out.

It then showed that the crank was loose on the stem and also a new key was needed. Further investigation



DETAILS OF RADIUS ROD BEARING THAT CAUSED KNOCK

showed that the stud A on which the radius rod connected the crank E to the wristplate worked too loose in the hole or eye of the crank E.

It was decided to tin the stud A and the valve stem B. Accordingly the surfaces were cleaned and tinned all around where they had a bearing, then a fine file used to remove no more metal than actually necessary to allow the crank E to be driven tight onto the valve stem B and the stud A into the crank E.

On assembling the gear it was found that there was more space between the shoulder C and the rod end F than good practice called for, so the stud was put in a lathe and squared up at G and the thread H cut up close to the shoulder so that when the nut was tightened up only the right clearance for a working fit was given.

After assembling and starting the engine the knock has disappeared.

Another way to remove the excessive clearance

between the shoulder C and end of radius rod would have been to put a washer of a diameter not exceeding that of the shoulder C between the rod end and the shoulder. RECEIVER.

Removing Rust and Paint-Set Fittings

WHENEVER it is possible to get old rust-set, or time-set fittings into a fire, make the fitting and the end of the pipe a dull red hot, then cool them or allow them to cool, then hammer them around the threaded end but not so hard as to distort them. After this treatment, they can usually be separated without marking them to any extent with the pipe wrenches or the vise jaws.

If a fitting and pipe end upon which the fitting is set can be made red hot and while in this condition, instantly plunged under water and left there until cooled, they can be separated in every case with ease with little or no hammering. This treatment sometimes results in making malleable fittings brittle; with cast-iron fittings over 2 in. in diameter, a crack by unequal or rapid contraction is a possibility; with smaller sized fittings, such cracks are not probable, although possible. I have seen many thousands of old set cast-iron fittings of small diameter treated in this way and the percentage of cracked fittings caused by the treatment was so small as to be of little importance, much smaller, in fact, than would have been the case with almost any other method and none of the pipe ends were destroyed, which certainly would not have been the case if any other method consisting of pure force were used.

A set fitting can be removed by making it and the pipe end a dull red hot, then cooling the pipe near the fitting to prevent the vice jaws flattening it while force is applied to remove the fitting. A malleable fitting is often flattened by this method. Both should be cool whenever possible. Men who have had no great amount of personal experience along this line will argue that such treatment will cause many cracks in small cast-iron fittings. My own considerable experience has proved otherwise. Of course brass fittings should not be treated in this manner for several reasons. Usually, with care, they can be separated without injury to the pipe or fitting. Another point worth consideration is the number of pipe wrench and vise jaws which are ruined by using them upon hot pipe and fittings. In many cases it costs more in time to remove a fitting than what the fitting is worth. If the fitting is cast iron, it will often pay simply to break it apart. JAMES E. NOBLE.

Power Plant Operating Record

A DETAIL that is a bugaboo to some engineers in modern engineering practice is that of keeping the logs and record sheets. Personally I am a strong advocate for well kept records. I know their value and I appreciate the information that recording instruments can give me. I am thoroughly opposed to the system employed in a great many plants, where a log sheet is made out for each individual instrument.

I have in mind as I write this a mill where they have 32 report forms to be made out daily. The city water meter reading was made out on one slip, the V-notch meter reading on another slip, the turbine daily load on another slip and so on.

One afternoon while in the chief's office (a very orderly man, this chief) he suddenly set up a great howl about how the charts were accumulating in his office, making the statement that in a short time he would have no office and that was just what I had been waiting for. I put a proposition up to the chief and while he could not see my idea at that time he is converted now.

My idea is shown in the accompanying chart, which should be helpful to anyone designing an operating chart. Instead of making out a separate slip for each item, as was the custom, I have put the whole week's record, 16 items, on one sheet of paper 8 by 11 in., and taking in the readings of 26 instruments. It makes a simple chart to read and errors that were common in

WEEK ENDING March 20th WEEKLY LOG SHEET.

DATE						
DAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
WEATHER	Rain	Cloudy				
BAROMETER	30.5	29.94				
CITY WATER METER READINGS.						
METER	35042.65	35046.36				
USED CU. FT.	391	205				
V-NOTCH METER READING.						
METER	968813	971990				
USED LBS.	1363308	1564500				
TURBINE OUTPUT.						
METER	3892	3892				
K.W.H. OUTPUT	10,000	10,000				
SYN. MOTOR.						
METER	8044	8531				
K.W.H. OUTPUT	4700	4900				
FUEL OIL DATA						
RECEIVED	4-1800	6-1800				
USED IN WORK DAY	5830	6830				
USED IN NIGHT	1700	1590				
USED IN FULL DAY	7530	7620				
INCOMING METER	648177	649320				
RETURN METER	201018	201468				
BOILER	C-O-2 RECORDER READINGS.					
1	10%	10%				
2	13.5%	12½				
BOILER	STEAM FLOW METER DATA. EVAPORATION.					
1	16.5	14.9				
2	15.4	15.6				
BOILER	STEAM FLOW METER DATA. H.P. DEVELOPED.					
1	690	620				
2	525	520				
BOILER	STEAM FLOW METER DATA. RATINGS.					
1	139	134				
2	126	120				
TIME	FEED WATER TEMPERATURE. DEGREES.					
6AM	240	245				
10	245.5	245				
2PM	240	250				
4	237	250				
CONDENSER WATER TEMPERATURE.						
INCOMING	40	42				
OUTGOING	70	73				
DIFFERENCE	30	31				
TIME TAKEN	3 AM	11 AM				
HORSE POWER DEVELOPED.						
I.H.P. OF ENGINE			2172.760			
K.W.H. OF ENGINE			1637.878			
K.W.H. OF TURBINE			1260.000			
TOTAL K.W.H.			2897.800			
TOTAL H.P. DEV.			3840.000			
LOW P.I.H.P.			667.760			
HIGH P.I.H.P.			1783.000			
TIME TAKEN			9:30 AM.			
DAILY AVERAGES.						
VACUUM	29.3	27.6				
STEAM	173	172				
RECEIVER	4	4				
EVAPORATION	15.9	15.2				
ECONOMIZER TEMPERATURES						
IN	320	305				
OUT	380	372				
DIFFERENCE	60	65				

CONDENSED WEEKLY LOG SHEET USED IN INDUSTRIAL PLANT

the slip system are readily seen and can be corrected. One of the great faults with the slip system was that when different men took the readings they often failed to agree. With my chart this cannot happen because the previous figures are right before one, and the last reading can be checked up with the present reading. Still another detail is the ease with which changes in the output of the meters can be detected. In making out the chart data, one would be sure to note any great change in the output or input because there is always in a chart of this kind a table of averages.

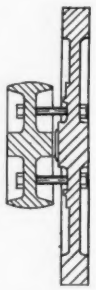
The item of expense is also worth considering. In this plant they used 192 printed report forms weekly. With my chart we use one typewritten sheet. The difference is about $7 and we still have the meter data in a more compact and neater form.

In the log sheet shown in the sketch I have given those items which are generally recorded in all well-kept plants. It is an easy matter to enlarge the chart to take care of temperatures, pressures, etc.

I have also in my chart given two actual working days' record for my own plant; this shows my method of laying the work out. ARTHUR D. PALMER.

Repair to Flywheel Pulley

WE HAVE a portable gas engine saw rig. Through an accident the drive pulley, which is only a rim bolted on the flywheel, got broken and there was no other on hand to replace. The shaft does not extend over half an inch out of the flywheel. The saw rig being needed



BELT PULLEY BOLTED TO FLYWHEEL

nearly every day, a pulley of the same diameter was gotten from a mill, three ⅝-in. holes were drilled in three of the spokes and the pulley was bolted on the flywheel, using three pieces of ¾-in. pipe as spreaders and three ⅝-in. bolts. CHAS. LABBE.

Art of Doing

A PNEUMATIC tube carrying leather boxes was "stopped up." The tubes where they meet are covered with a collar, a band with tightening screws placed at each end of the collar to prevent leakage.

These collars must fit snugly and because of the way the pipes are hung it is not practicable to untwist

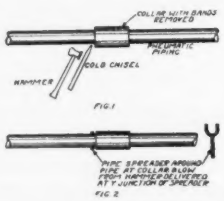

COLLAR WITH BANDS RETAKED
PNEUMATIC PIPING
COLD CHISEL
HAMMER
FIG. 1
PIPE SPREADER AROUND PIPE AT COLLAR BLOW FROM HAMMER DELIVERED AT T JUNCTION OF SPREADER
FIG. 2

FIG. 1. COMMON METHOD OF DRIVING COLLAR ALONG PIPE
FIG. 2. USE OF PIPE SPREADER FOR SLIPPING COLLAR ALONG PIPE

them, therefore it is quite a job to open up the piping, so here is where the art of doing comes in.

The first mechanic grabbed a cold chisel and a hammer, using these tools as shown in Fig. 1, and after a long time he slid back the collar, but not until it was so badly mutilated it was unfit for further service.

In another building, a similar system became clogged. A real mechanic picked out of his tool chest a hammer and a pipe spreader. Fig. 2.

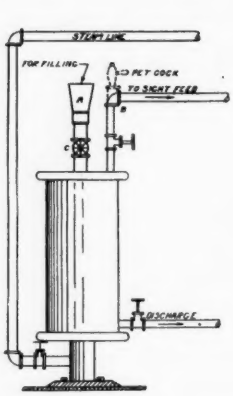
The bands being removed at the collar, the "spreader" was wrapped around the pipe and a few well-directed blows with a hammer on the bifurcation of the "Y" shaped tool, the collar slid back with no visible signs that it had been subject to a severe jolting.

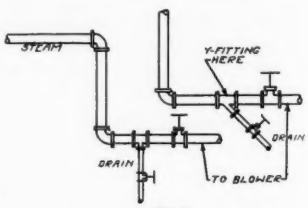
We have an object lesson right here, and we are also reminded that it is not true that it is a poor workman who complains of his tools, but it is a poor workman who does not understand tools. J. B. DILLON.

Suggested Changes in Pipe Connections; Eliminating Idler Pulley

IN REGARD to Improvements to Oil Tank and Steam Hose Connections, by H. A. Jahnke, April 1 issue, page 381, a gate was left open for further improvement. The valve on the steam line should not be placed above the tank if the tank is emptied before filling. The tank should be filled at the same time that the discharge valve is opened and it will fill as fast as water drains out without any trouble. If tank is drained first and then filled, air would be trapped in line from tank to valve and would be a source of trouble to the sight feed.

Referring to the blower connection, this is well meant for those who are careless, but to place a tee or Y between valve and riser with ½-in. bleeder would give





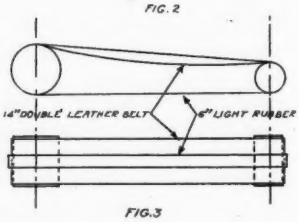
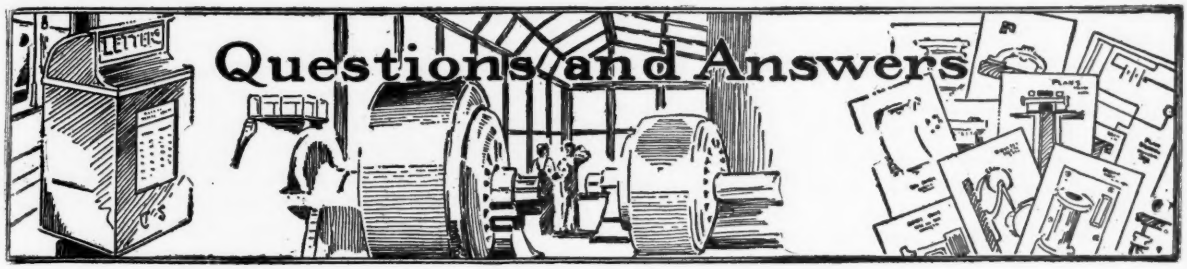


FIG. 1. SUGGESTED CHANGE IN LOCATION OF STEAM VALVE
FIG. 2. PIPE DRIP SUGGESTIONS
FIG. 3. COMPOUND BELT DRIVE

better results as water would travel with the steam instead of in the opposite direction to the trap as shown in Fig. 2 of Mr. Jahnke's article.

Discard idlers on long-belt drives and get more service from your belt, which seems skeptical but has proven by test, by having main drive belt ordinarily tight and placing smaller belt over it about 2/5 of the width of main belt. This will make the main belt hug the pulleys close and prevent slipping, also cause it to run quieter than with idler on and give longer life to the belt. Rubber belt or single leather belt will do for heavy belts.

E. G. M.



Maximum Boiler Rating

I SHOULD like to know what is the opinion of the readers of Power Plant Engineering as to the maximum rating at which it is advisable to drive a horizontal return tubular boiler? Our boilers are old but in excellent condition. They are rated at 100 hp. We have recently installed new grates and furnaces and are now able to get, without any great difficulty, 210 per cent of rating. I have heard that 140 per cent was the maximum at which it is desirable to drive this type of boiler, but I would highly appreciate other opinions on the subject. G. S. M.

Flywheel Design

WHAT WILL be the axial length of a flywheel, made of iron (weight, 480 lb. per cu. ft.), normally traveling at 1200 r.p.m., rim speed 10,000 ft. per min., which will deliver 50 hp. sec. of energy in reducing from 1200 to 1150 r.p.m.? R. P. S.

A. The question calls for the width of the face of the wheel when nothing is said of the thickness or depth. The area of the section is what is sought and any combination of width and depth that will give the desired area will answer. It is stated that the wheel is to do 50 hp. sec. of work, but the necessary time element is omitted. Again we will assume that this work is to be done in one second, i. e., 50 hp. sec. per sec. or 50 hp.

The energy of a rotating body having a rim speed V_1 and weight W is $WV_1^2 \div 2g$ and at a rim speed V_2 is $WV_2^2 \div 2g$ so that the energy involved in a change of speed from V_1 to V_2 is $W(V_1^2 - V_2^2) \div 2g$ ft.-lb. Here g is the acceleration due to gravity = 32.2 ft. per sec. per sec. The energy involved 50 hp. per sec. = $50 \times 550 = 27{,}500$ ft.-lb. per sec.

The initial velocity is 1000 ft. per min. or 167 ft. per sec. and the final velocity is $1150 \div 1200 \times 167 = 159.5$ ft. per sec. Solving this equation for the weight W, we have

$$27{,}500 = W(167^2 - 159.5^2) \div 64.4$$
$$27{,}500 = W \times 38.1$$
and $$W = 27{,}500 \div 38.1 = 722 \text{ lb.}$$

As the iron used weighs 480 lb. per cu. ft., the volume of the rim will be $722 \div 480 = 1.5$ cu. ft. or 2600 cu. in. The volume is also equal to

$$V = 3.14\,(2R - h)\,h \times l$$

Where R is the radius, h the depth and l the width of the face of the wheel

$$R = 10{,}000 \div (2 \times 3.14 \times 1200) = 1.33 \text{ ft.} = 16 \text{ in.}$$

If we assume that the depth of the rim is, say, 6 in., we find

$$2600 = 3.14(32 - 6)6 \times l$$
$$= 490\,l$$
from which $l = 2600 \div 490 = 5.3$ in.

If it is desired to have a wider face, the thickness of the rim should be reduced in proportion.

It is to be noticed in passing that the rim velocity of 10,000 ft. per min. is high for cast iron. Ordinarily such wheels are designed for rim speeds not to exceed 100 ft. per sec. If the wheel be redesigned for a lower rim speed at the same angular velocity, the diameter will have to be decreased and the amount of metal used increased.

Boiler Backfires

IN THE May 15 issue of Power Plant Engineering, G. P. inquires as to the reason for the backfiring of a boiler, hand-fired with shavings.

The number of boilers in the plant is not definitely stated, but from the text I assume that there are two, in which case the 4-ft. diameter stack should be entirely sufficient.

I have had considerable acquaintance with the use of this fuel and can assure G. P. that the backfiring is due to the explosion following the ignition of the gas generated from the shavings by the heat from the boiler brickwork, when the quantity of shavings fired at a time is considerable.

There is naturally a strong tendency to fire heavily with shavings, as they burn quickly at best and if this is not done there can be but a small interval between firing periods.

There is a large amount of gas released upon the heating of shavings and its explosive power when mixed with the proper proportion of air is enormous.

The writer knows of two fatalities occasioned by such accidents, in one of which the son of the engineer was the victim.

A positive preventive will be found in thoroughly igniting the surface of the shavings after firing and before closing the furnace door. This may ordinarily be easily and effectively done by lifting up and pushing back the shavings at the front end of the grate so that the front of the fire has a chance to sweep over the top of the fresh charge.

If it appears that this method has a tendency to cause an objectionable hole in the front of the fire, the shavings may be ignited with a red-hot bar which is conveniently had by placing a bar of scrap iron 3 or 4 ft. long into the fire when about to fire a fresh charge.

It will be found a convenience if about 18 in. at one end of the bar is bent to a right angle as then the bar may be pushed in out of the way and the end hanging down will provide a cool handle by which to take hold of it.

It is my opinion that there is a perceptible saving of fuel effected by thus preventing the escape of

unburned gases in addition to the safety feature, although in some cases the fuel saving may not be a material factor. CHARLES L. WARE.

SUCH EXPLOSIONS taking place in hand fired furnaces are not only serious but extremely dangerous. Just recently I was called on to eliminate a hazard of this nature, where a fireman was bruised and burned to such an extent that he will be disfigured for life.

The cause of such explosions in devices burning fuel (it need not necessarily be a steam boiler furnace; it will happen in the common small cooking range) is that the combustion space above the fire is full of combustible gas and no free oxygen to ignite it; consequently when a door or any other part of the furnace is opened, causing an inrush of air which comes in contact with the combustible gases, combustion takes place so rapidly that an explosion results. An explosion of this kind will occur when the setting is perfectly tight and there is no air entering over the fire.

In the case of explosions after firing the firing doors are opened wide and there is an inrush of air which fills the setting and furnace and it makes no difference whether shavings, coal (of the finer grades) or rubbish is fired, if the fuel bed is covered or slightly smothered so no air can pass up through it, the explosion will take place when the firing doors are closed, as the combustible gas which will rise in a large volume from the fuel will mix with the air in the furnace and setting, causing an explosion. These explosions not only come back through the firing doors but affect the whole setting. In the incident I mentioned, the front cleaning doors were blown open by the explosion which was of such force as to break the cast-iron catches. The means which I used to eliminate this dangerous method of firing shavings was to attach a "Y" to the discharge pipe from the blower in the shaving bin with two 5-in. galvanized iron pipes. These I connected to the furnace at the front of the boiler, one on each side and above the firing door, with a piece of common cast-iron pipe 12 in. long extending into the furnace. This allows the shavings to be delivered on the grate on each side, leaving the center with a thin fire. When burning shavings it is impossible to get the required air up through the mass but the air passing up through the center of the grate mixes with the gases passing off the surface, causing better combustion. The flow of shavings and air is regulated by slides or dampers in the pipe close to the front of the boiler. It was necessary to install a new set of grates as the air mesh was ⅜ in. and even with shavings this is not ample for the amount of air needed; the present set is ½ in. This change not only stopped the explosion hazard but has made the efficiency and operation 50 per cent better. The cost of this change is nothing as compared with what the cost is to the fireman who was disabled.

If G. P. is not so equipped as to have the shavings blown into the furnace, it would pay him to have bins made and a small fan installed to feed his boilers.

CHAS. J. MILLER.

IT IS EVIDENT from G. P.'s question that while the shavings are being fired the flue gases are extremely rich in combustibles. It is probable that his front connection doors leak a considerable quantity of air that mixes with the flue gases. Then if the brick work around the boiler head allows the flame to bypass to the uptake, we have ideal conditions for combustion just as in an internal combustion engine and an explosion occurs, causing a waste of heat as well as an extremely dangerous condition. I would suggest that he repair his brick work and stop the infiltration of air.

Leave the fire doors open a few inches after firing until the gas is partly driven off. This will allow the hydro-carbons to be more completely consumed in the combustion space instead of exploding in the uptake. Keep the combustion chamber free of ash, also investigate the stack to see if the base is filled up. Dampening the shavings somewhat may help. By raising his boiler a foot or two he would make the setting more suitable for burning high volatile fuel such as this.

ARTHUR TEMPLE.

Cause of Leaky Tubes

REPLYING TO W. C. B.'s question, I must say there are many things to cause boiler tubes to leak. The article does not mention how the boiler is cleaned inside or the amount of scale that is accumulated on the head and tubes between cleanings. The fact that the tubes are too brittle to be used after only 11 yr. service shows that there is something in the feed water or compounds used together with the excessive heat from the boiler being overloaded, which causes the tubes to become crystallized and brittle at the ends. In such cases, there is some danger of rolling such tubes too often and too hard. In this brittle condition, it is general to find the beads on the tube ends as well as the tube where rolled in the head becomes very thin so there is insufficient metal to hold a tight expansion against the edge of the tube hole only until the tube becomes hot again, when it contracts, or "sets" to a size enough smaller to allow it to leak. When the tubes become badly crystallized the beads often break off. The tube must be of sufficient thickness to hold its place after it is expanded and beaded over.

In rolling tubes it is necessary to use some care as excessive rolling of one tube will cause the next one or two beside it also to leak, also constant rolling of tubes, so expands the hole in the tube sheet that the tube is constantly enlarged to fit the hole. In doing so, the metal is stretched out to the larger size and becomes thinner.

This will be noticed when new tubes are put in, as a thin piece of metal has to be put outside of the tubes at the ends to bush the holes down to fit the tube. If the metal between the tube holes is not thick enough or if space enough is not allowed between the tube holes to give sufficient cross-sectional area of metal to expand against, the tube sheet itself will give way to the expander and become set in the expanded condition. If the scale happens to become thick on the back head at any time the tube ends as well as the tube sheet will become sufficiently overheated to cause leakage. A tube sheet thus burned cannot be made to hold tight by rolling the tubes.

The feed water pipe may be discharging so close to the rear head that it sets up strains at this point and thus causes leaking.

The leaking of the new tubes so soon after they were put in shows that in renewing a set of tubes and beading them all over there is a tendency to make one

beaded end pull more on one tube than on another. This is caused generally by the boiler maker flaring the edge of the tube end slightly with the hammer before using the expander, so that when he drives the expander in the tube, the tube does not go back through the hole in the tube sheet too far to be beaded over. After the first rolling, he flares the tube end with a hammer which makes it draw like a rivet. Doing this with one or two old tubes, one would soon have them all loose and leaking.

When old tubes are to be rolled and beaded up to make them tight, especially where the metal is brittle, great care must be used not to roll the tube too hard or to strike too hard blows with the hammer when the beading is done. The fact that the tubes become crystallized shows that there is something in the feed water to cause this. If steam from the engine is used for heating purposes and the returns used in the boiler water supply, there may be sufficient oil coming back, if discharged near the back head to cause just such leaky tubes as mentioned, especially if well water is used for boiler feed and its scale forming impurities are of a mineral lime nature.

Scale and oil must be kept out the boiler and where oil is present, a proper solvent should be used which will not only cut the oil but which will also loosen the scale. If tube cleaners have been the cause of the trouble, the elimination of their use would result in the tubes remaining tight. The fact that the boiler is 11 to 15 yr. old leads one to believe that the age is causing crystallization of the tube sheet and shell. If caustic potash has been used in any quantity at any time for boiling out the shell, this crystallization is sure to result. The less potash used the better. Sal soda is strong enough. Better still, have an analysis made of the feed water and then use a treatment that will correct the trouble.

R. A. Cultra.

Cause of Air in Water Supply System

In reply to R. J. W.'s question on page 538 of the May 15 issue, concerning his milky colored water, I would say that after careful study of the problem I have come to the conclusion that his pump needs overhauling. It is possible that water leaks past the plunger or back through the valves. This would cause churning which, when excessive, will cause a milky color. The air in the water is possibly drawn in through the packing gland. An important point on which R. J. W. failed to comment is whether the water was pumped into the tank through an independent pipe, or the discharge from the pump was connected to the outlet pipe leading from the tank. In the latter case, air would be carried by the water from the pump directly to the faucets as it had no chance to escape through the tank, and, in addition, the water would be continually agitated and would have no chance to settle. There should be two separate pipes; one leading from the pump to the tank, another outlet pipe leading from the tank to the various mains. More satisfactory results can be obtained by installing another tank close to the town about half the size of the present one. Both tanks should be connected together. This would give the water a chance to settle and any air carried over would be released through the second tank, provided there is a vent at the top. In addition, by having two tanks, there would be an extra storage of water. In case the pumps should fail or break down through any reason this would prevent the town from going dry. Patrick Molloy.

Cause of Increase in Vacuum

On page 487 of the May 1 issue of Power Plant Engineering, I noticed a question: "What causes this increase in vacuum?"

While I cannot give a direct answer to the question as to why this 2-in. increase in vacuum is obtained on the afternoon load over the morning load, I can say that I have found, some years back, that the vacuum can be greatly improved on a barometric condenser, not only by painting the flanges, as mentioned by G. L., but the entire condenser, tail pipe included, with some elastic paint which does not crack. This paint should be applied while there is still a vacuum on the condenser and it is still warm, in order to make the paint flow readily. With vacuum on the inside, wherever there are pores in the cast iron, the paint has a tendency to be drawn into these pores.

Previous to painting our barometric condensers this way and whenever the vacuum was lower than usual, we purposely opened a ⅛-in. vent, which caused the vacuum to drop to about 18 in. in a few seconds, after which the vacuum would frequently return to a point from 1 to 1½ in. higher than that obtaining prior to opening this small vent. What the cause of this increase in vacuum was, I am frank to state, has always been a puzzle to me as well as to other engineers in this plant, but we do know that it worked.

After reading C. L.'s question I am now inclined to think that it was the sudden increase in temperature of the condenser, by lowering the vacuum, which caused an expansion of the metal and which closed up some of the leaks temporarily. I am positive that the painting of the barometric condenser will make an improvement in this plant.

If any of the readers can give me their opinions as to what caused this increase in vacuum, by first dropping it some 6 or 7 in. I shall appreciate it. A. J. G.

Exhaust Runs Hot on Oil Engine

What is the cause of excessive temperature at the exhaust of a semi-Diesel type oil engine? The exhaust is smoky and frequently accompanied by flame. This condition has been noticeable only for a short time. Previous to that the engine had been performing in an entirely satisfactorily manner. G. H. S.

A. The cause of your trouble may be due to any one of the following conditions which we have listed in the order of their importance and their likelihood to cause the trouble:

1. Your load may have increased beyond the capacity of the engine to such an extent that more oil is being supplied by the injection pump than can be burned in the cylinder. The result is incomplete combustion. This means that combustible gases are carried along in the exhaust which ignite when they are discharged into the atmosphere.

2. You may have a poor lot of fuel oil on hand, an oil of slow burning qualities.

3. There may have been a change in the exhaust piping such as to produce an increase in back pressure.

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Recruits for the Power Plant

At this time each year, the technical schools of the country are turning thousands of engineering students into industrial occupations. Unfortunately power plants as a rule have not availed themselves of this opportunity to secure employes trained to think and to develop them into specialized operating engineers and superintendents.

Operation of a power plant is essentially the application of sciences to the production of power; without a thorough knowledge of the sciences employed, the application becomes merely the following of directions laid down by somebody in authority or by the manufacturer of the equipment installed, without a logical reason in the mind of the operative for the course he is following.

Problems come up daily for solution which involve the application of such sciences as mathematics, physics, chemistry, economics, psychology, and the industry is in need of more men who are able to solve such problems logically.

Modern power plants are being made more attractive places in which to work than ever before. The drudgery which prevailed a few years ago is disappearing; mechanical coal and ash handling is the common practice except in the smallest plants; mechanical stokers have relieved the backs of firemen; mechanical soot blowers and tube cleaners have taken other drudgeries out of the plant; automatic control of combustion and water level have given the attendant greater opportunities for studying his combustion problems, which has resulted in more efficient operation; instruments for revealing nearly every existing condition are available; oiling systems, ventilating systems, safeguards of many kinds, clean, wholesome lavatories and bath rooms, and even reading and rest rooms in some plants make the power plant industry attractive to those who have a liking for the application of sciences.

The young mechanical or electrical engineering graduate who is willing to start at the bottom will find in the power plant an excellent opportunity to gain practical experience with a great many pieces of equipment such as pumps, heaters, boilers, piping, stokers, fans, engines, turbines, compressors, generators, motors, transformers, etc., any one of which may be made the subject of special study and development well worthy the time of any engineer.

Superintendents and chief engineers of power plants who are in need of recruits will do well to look over the credentials and school records of engineering students who are finishing or about to finish their courses and arrange with the most likely men to take an apprenticeship course. Many of these graduates would be glad of an opportunity to join the operating force and could be made of immediate value particularly in test work and investigating unusual conditions. Their laboratory training will often suggest methods of procedure which can readily be applied in practice to meet an emergency.

The power plant industry needs these young engineers especially in the operating field, where the personal element influences so largely the results obtained and where work is likely to become purely routine and nonprogressive unless driven ahead by the fire of youthful ambitions.

Electric Power Influences Farm Population

In many respects, city life is considered to be more attractive to the average individual than farm life. The proportion of city dwellers to total population is yearly becoming greater and is now considerably more than 50 per cent. Statistics show that of the men who were mustered out of the army at the end of the war, less than 2 per cent went back to the farms. Evidently much more than 2 per cent of our soldiers was recruited from the country, hence it is evident that farm life was not sufficiently attractive to those men to take them back after once having been away. Is this condition desirable? If so, we are apparently on the right track; if not, what is causing it and what remedy can be applied?

If our country is to continue to prosper, it is imperative that a large portion of our population work on the farms. To secure this, it is necessary that the farmer be provided with more of the conveniences that are available in the city. Electric power and light banish many drudgeries of farming for both men and women and should go far toward making farm life more attractive, especially for those who have experienced their usefulness.

Supplying of electrical energy to rural districts has, in the past, been looked upon askance by the public utility companies. As it has been demonstrated, however, that such service can be supplied at a profit, utilities are beginning to realize its possibilities and are extending their lines in every direction, as pointed out in an article on this subject in this issue.

Aside from the consideration of financial gain there is a motive involved that, on the face of it, appears somewhat altruistic. The farmer wants and needs this service and it is to the interest of the urbanite that he should have it, even to the extent of helping to finance the proposition. Any improvements that will aid in reducing the cost of production of food will react on the consumer and everyone will be benefited. By making farming more attractive, more people will take up that occupation which is in reality the basic industry of the country for producing the necessaries of life.

Expedition Factor

Between the time a man decides that he should do a certain thing and the time he actually starts to do that thing, time elapses. The length of this time varies naturally with the magnitude and importance of the work to be done, but depends more upon the character of the individual than upon any other factor. We have all seen human dynamos who make quick decisions and start immediately to execute their plans; but the great majority of people are prone to deliberate, make decisions slowly and procrastinate more or less in getting the work started and finished.

Here is an analogy to the operation of an alternating current generator carrying an inductive load; the voltage may be compared to the thoughts which inspire action while the current is compared to the activity in doing the work. The work done in the case of the generator is the product of voltage, the current and a fraction called power factor. In the case of human activities, the result is proportional to the value of the idea, the magnitude of the effort to accomplish the work and the expedition with which the work is performed. May we call this the "expedition factor"? And let us see what it means in bringing success.

If this human organism in which I am housed is not delivering the goods which I believe it is capable of, I want to know just why. I want to know if the ideas are lacking or are of the proper kind to inspire action. I may find the physical part of my habitation does not respond to its task and is retarding progress, lowering my "expedition factor." Again the factor may be leading instead of lagging; that is, I may be acting on impulses, trying to develop half-baked ideas with sure failure at the end.

In electrical work we correct power factor by installing capacity or inductance depending upon whether the current is lagging behind or leading the voltage wave. With the human machine, the correction for a leading expedition factor is education of the mind to think logically, rapidly and with decision, to plan ahead of time what course to follow in the hours and days to come; to correct a lagging expedition factor, the body must be trained to respond without delay to what the mind thinks should be done.

Somebody has said that anybody will make a success if he will do, without delay, the thing which he knows to be right; which is merely bringing up your expedition factor. We all need a little self-analysis; if our expedition factor is low, let us analyze the kind of load we are pulling, it may be too long hours with lack of concentration, too many side lines, social activities, wrong environment, lack of education, insufficient training or any one or more of a number of other factors, all of which may be overcome by proper thought and action. But nobody can expect to attain his highest possible success unless he carries out promptly the plans he is continually formulating for himself—working at 100 per cent expedition factor.

Power Plant Slogans

Keep and Analyze Operating Records in Every Power Plant.

Develop Water Power Sites.

Promote Health and Safety in Power Plants.

Handle Coal and Ashes Mechanically.

Employ Engineers for Engineering Work.

THE DEPARTMENT OF COMMERCE calls attention to the fact that the returns of the 1919 census of manufactures indicate a general and marked decrease in the prevailing hours of labor. Of the 9,096,372 wage earners reported by that census, 4,418,693 or 48.6 per cent were employed in establishments where the prevailing hours of labor per week were 48 or under, while in the previous census, covering the year 1914, the number employed in this class of establishment was only 833,330 representing 11.8 per cent of the total number of wage-earners.

The establishments in which the hours of labor were 48 per week in 1919 employed 32.6 per cent or about one-third of the total number of wage earners, and those in which the hours were less than 48 employed 16 per cent of the total.

Protection of Steel Bins from Corrosion

By JOHN V. SCHAEFER

BITUMINOUS coal, having a high percentage of sulphur, and hot coal ashes, have a highly corrosive effect on steel with which they remain in contact for any appreciable length of time. This corrosion is caused by the chemical disintegration of the sulphur, forming a weak sulphuric acid which attacks the steel. This action is accelerated by heat and moisture and is therefore particularly severe in large power plants using stokers, where coal is either purchased in the form of slack, or crushed to the size of slack, is wetted down to prevent dusting and many times is stored in inside bins subjected to the heat of the boiler room. Under such conditions the life of a¼-in. steel bottom plate in a bin has been known to be as short as 6 yr., in which time the plate rusted through.

FIG. 1. CORRODED BIN PLATE

Figure 1 shows what such a bin plate looked like after an effort had been made to knock off the scale. Linings put on with cement guns have become common, as a reinforced Gunite lining in a steel bin has proved itself to be durable and entirely satisfactory for preventing corrosion and attrition of the steel plate in the bin.

Perhaps the severest test to which such a lining can be subjected is when it is used in a bin of the suspended steel plate type. These bins hang from the top like a parabolic shaped bag. The forces acting upon the various parts of this suspended bag vary with the various degrees of loading and their method of emptying. The shape which this bag tends to take when it has a small load right at the bottom, tending to make the sides take a straight line, is different from the shape it tends to take when the bin is full and carries a surcharge load. In the former case it tends to form a "V," and in the latter it tends to take the form of a "U." These forces in a parabolic bin of some size are great enough to crack a concrete lining of considerable thickness. Since distortion cannot be avoided, it is best to make the

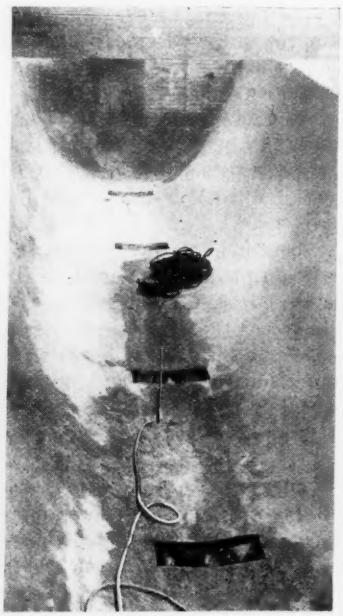


FIG. 2. COAL BIN WITH 2-IN. LINING OF GUNITE
FIG. 5. CONSTRUCTION AT TOP OF COLUMN

lining in such a way that it will not be injured by this distortion. A reinforced lining 1½ to 2 in. thick has been found to have a considerable degree of flexibility.

Figure 2 shows the inside of such a parabolic coal bin which was lined with 2 in. of reinforced Gunite by the Cement Gun Construction Co., in Michigan City, in 1913. By actual measurement it was found that the sides of this bin moved in and out—"breathed"—as much as 1½ in. in successive filling and emptying. Yet a critical examination made 5 yr. later by the engineers, under whom the work was originally done, failed to disclose any cracking or deterioration of any sort, and within the past year another examination by these engineers disclosed that the lining was in as good shape as when it was put in 8 yr. ago.

The application of a 1½-in. coating on the inside of a new steel bin, making a 1½-in. protective coating over all of the plates and such structural members as may be surrounded by the coal, is a comparatively simple matter and not very expensive. The practice, therefore, in locations where high sulphur coal is liable to be used, has become almost universal. A much more difficult problem, however, arises when an unlined steel bin has already corroded to the point where its structural strength has been seriously impaired. A mere lining is then insufficient and there must be incorporated with it a supporting structure that will carry the load.

A typical case of the kind where the corrosion has progressed to the point where the strength of the structure is impaired was that of a steel coal and ash bin at the plant of the Bloomington & Normal Railway & Light Co., at Bloomington, Ill. This was a steel coal bin 110 ft. long, 15 ft. wide, and 15 ft. deep, carried

on steel columns, the bottom being divided into flat-sided hoppers—six for coal and one for ashes. The ash bin occupied one end of the structure and was separated from the coal bin by a partition which extended above the top line of the bin to the underside of the conveyor which was used for putting coal into the bin.

The shape of the inside of this structure is clearly shown in Fig. 3, which is a view looking down into the coal bin, with the partition separating the coal bin from the ash bin shown in the background. This photograph shows the bin at the time the reinforcement was in position and the shooting of the Gunite ready to begin. During 1921 an examination of this structure showed that it was urgently in need of repairs.

When the bins were emptied and an effort was made to remove the scale, it was found that the plates were so far gone as seriously to weaken the structure. A new Gunite coal bin had to be built in such shape that the loads would be carried to the columns which, from the

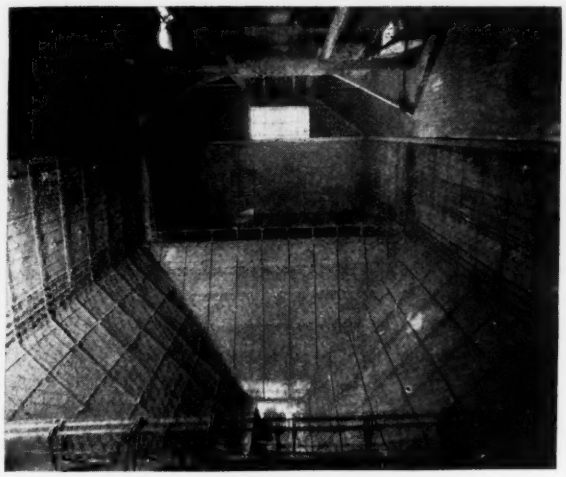


FIG. 3. INSIDE OF STEEL BIN READY FOR APPLICATION OF GUNITE

bottom line of the bins downward, were in a good state of preservation and with plenty of strength to carry the load. Reinforcing steel was therefore provided, designed to take all the tensile stresses. The outside long walls were designed as continuous girders taking the load down into the steel columns through pilasters which rested on top of these steel columns. The bottom load was carried up to transverse cross beams made of reinforced Gunite, which beams were tied into the pilasters, in that way throwing all of the load of bottom and sides into the columns. The details of this are clearly shown in Fig. 3. The reinforcement consisted of steel rods and steel wire mesh.

The openings from the bottoms of these bins to the spouts leading to the stokers were so badly corroded that they had to be repaired. New cast-iron bin gates were made and these were secured to the new structure in such a way that the load of these was also carried by the new bin.

The existing steel plates were thoroughly cleaned of loose scale by hammering and by sand blasting with air and water at a pressure of 50 lb. Gunite was then shot into place with cement guns, leaving the inside of these bins as shown in Fig. 4.

Figure 5 is an isometric diagram of a panel point at the top of a supporting column with the column and the outside stiffener of the side wall shown in skeleton. The lining of side walls and on bottom was made 1½ in. thick.

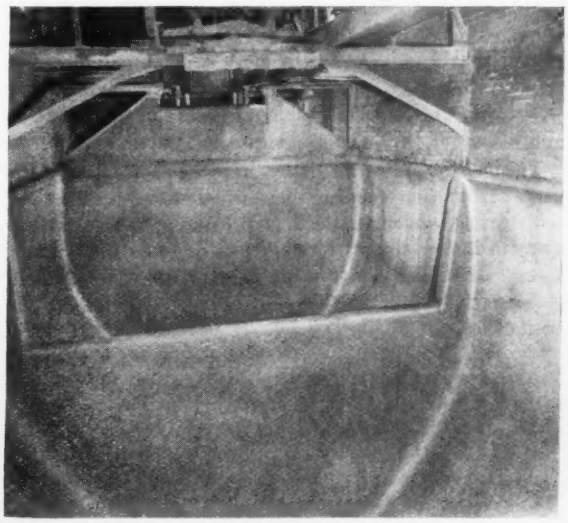


FIG. 4. COAL BIN AFTER LINING WAS COMPLETED

As the structure now stands, the inside of it is thoroughly protected against attrition and corrosion. The outside of the structure, which is only subjected to corrosive action to a very slight degree, is steel and this can from time to time be preserved by painting.

New Hand Tachometer

A NEW hand tachometer, the "Columbia," recently placed on the market by the Schaeffer and Budenberg Mfg. Co., has a number of distinctive features. It has an exceptionally wide range, the ratio of the maximum to minimum dial graduations is 400 to 1, covering all speeds ordinarily encountered in industrial practices. There are two ranges used, one from 20 to 8000 r.p.m. and the other from 40 to 16,000 r.p.m. This range is divided into five parts, 20-80, 60-240, 200-800, 600-2400 and 2000-8000 r.p.m.

A new patented oiling system provides for a 3 mo. supply of lubricant. Felt oil wicks act as filters, preventing foreign particles from reaching the bearings. Apparently special care has been exercised in constructing this instrument with the view of keeping out dust and dirt, thus keeping the "works" clean so as to give reliable readings.

Superheaters Used in Calumet Station

ON PAGE 504 of the May 15 issue it is stated that the boilers in the Calumet Station are equipped with Foster type superheaters. Since the article was published information has come to hand that the superheaters in all seven of these boilers were made by the Babcock & Wilcox Co. These are placed above the boiler tubes between the first and second passes of the boilers and are designed to give 300 deg. superheat to the steam when the boiler is operated at 4500 hp. which is 300 per cent of its rated capacity.

New Operating Head for Soot Cleaners

A NEW DEVICE, the ratchet operating head, designed to eliminate the human element in the operation of mechanical soot cleaners, has just been announced by The Vulcan Soot Cleaner Co. It is claimed that it will insure a more thorough removal of soot than has been possible hitherto in many plants, as a result of careless or too hasty use of the soot cleaning apparatus.

The basic principle is to limit automatically the sweep of the soot cleaning element, to force the operator to operate the element in a step-by-step movement, and hence to insure that the steam jets have an opportunity to sweep over and clean every part of the tube surfaces. A view of the element is shown in the accompanying illustration.

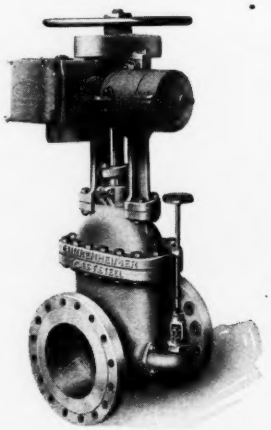
This head is so constructed that when the operator pulls the chain the element is rotated only a short distance, and can be turned no farther until the ratchet frame has been returned to its original position. Then a pull on the chain causes the element to rotate another space. Between the lulls in operating the steam jets have an opportunity to concentrate upon a definite section of the tube surface for a length of time sufficient to insure a thorough removal of the soot. When the complete arc of rotation has been attained in one direction, which is limited by stops, the mechanism reverses itself and the cleaning element moves back in the same manner, through the same arc. Any soot that may have redeposited after the first rotation is completely removed on the backward travel. The result is that the head takes the control of cleaning almost entirely out of the hands of the operator and gives a uniform cleaning in place of the irregular and uncertain rate controlled by the whim of the operator and his desire to get through with the job as quickly as possible.

VULCAN RATCHET OPERATING HEAD FOR SOOT CLEANER ELEMENT

Electric Valve Control

IN MANY industries, particularly the power industry, complicated piping systems are necessary, in which hundreds of valves are employed many of which are so located that should a serious break occur in the line, it would be almost impossible for a man to reach one to shut it off.

To make all valves accessible in case of an emergency as well as to facilitate their operation during the normal course of events various types of controls such as the hydraulic, pneumatic, electric solenoid and motor operated valves have been employed with success in certain fields. The use of the hydraulic and pneumatic valve, owing to the necessary size of the cylinder and in the case of the hydraulic unit, the liability to freezing, has been limited. The solenoid valve is only applicable in small sizes and where quick opening and closing is permissible. The electric motor system has found a more general application, but the difficulty encountered with this system was that of stopping the travel at the desired point, and thus preventing its jamming and breaking the parts or ruining the seats. While the addition of a separate limit switch mechanism tended to reduce this hazard, it was found that the momentum of the moving parts was sufficient to jam the valve on its seat, and that if momentum was relied upon to effect a final seating, the results were not uniform over a range in temperature and pressure of the fluid in the line.



10-IN. LUNKENHEIMER VALVE FITTED WITH DEAN CONTROL

Experience has demonstrated that in general the requirements for the successful motor operation and control of valves are 1; reliability under all conditions of moisture, heat and cold to which valves are subject; 2, certainty of closure in an emergency; 3, adaptability to all sizes and types of valves; 4, capability of installation on existing valves without shutting down the line, and 5, flexibility, accommodating the system to the various methods of local and remote, manual and automatic control necessitated by modern practice.

It is claimed that such a valve control recently brought out by Payne Dean, Ltd., satisfactorily fulfills these requirements. The Dean control is a unit system of motor operation for valves of all sizes. The motor, reduction gearing and adjustable limit switch are completely housed in a water-tight cast-iron casing. These units are equipped with enclosed water-proof high torque ball

bearing motors. The design of the reduction gear is such that the motor is allowed to attain full speed before the driving power is applied to the valve spindle. This action produces a hammer blow which overcomes static friction and unseats the valve. In closing, the limit switch mechanism automatically opens the power circuit and mechanically disengages the motor from the valve stem at the end of the travel. As the motor is disengaged the momentum is negligible and there is little if any tendency to jam.

The system may be operated from one or more remote control stations. These stations are equipped with signal lights that serve to show the position of the valve at all times.

Tests conducted by the Public Service Electric Company at Newark, N. J., under the auspices of the National Electric Light Association on several makes of valves equipped with this control, demonstrated the feasibility of closing a gate valve under extreme velocity, pressure and temperature conditions.

A 10-in. Lunkenheimer cast steel, monel mounted "Victor" gate valve fitted with this control was successfully closed in less than 30 sec. against a steam pressure of 225 lb. superheated 150 deg. F. The discharge end was open to the atmosphere and steam was allowed to blow through for 1½ min. before the valve was closed.

The accompanying illustration shows a Lunkenheimer valve fitted with this control which is now standard equipment on this make of valve.

It is of interest to note some of the conditions obtaining on this test. Eight 1250-hp. boilers were required to supply the necessary amount of steam which was used, for a period of about 2 min. on each valve tested, at the rate of about 320,000 lb. per hr. Steam velocities through the valve of 27,600 ft. per min. were obtained during the test, whereas velocities employed in normal operation are in the neighborhood of 8000 to 10,000 ft. per min.

Optimism Prevails at the N. E. L. A. Convention

ONCE MORE, after an absence of 2 yr., the members and guests of the National Electric Light Association assembled at Atlantic City on Monday May 15, to hold the forty-fifth annual convention of the association. The electrical exhibit held in conjunction with the convention which was staged on the Million Dollar Pier, perhaps the largest and most comprehensive ever staged at a convention, was an undeniable indication of the returning confidence in business in the electrical industry. Throughout the entire week, a spirit of enthusiasm and optimism prevailed. When the convention met at Chicago last year, business was dull and while the electric light and power companies were holding their own, there was a general atmosphere of resignation on the part of manufacturers. This year things were different. As the Official Convention Daily put it, "The smile that was forced at Chicago last year, is now natural."

The past year has witnessed steady improvement in the electrical industry and the outlook, according to president M. R. Bump, is even more promising. "Never has there been so much power plant business," said Mr. Bump, "and the production of electrical energy in March and April has been one of the surprises of the year."

Last year, according to Executive Manager M. H. Aylesworth's report, two billion dollars were expended for new building construction throughout the country. This, he said, set a mark never before approached. While the greater part of this huge expenditure was made in cities for the purpose of housing people, it resulted in producing additional requirements for electric service and the electric light and power companies as well as the manufacturers, were benefited.

With such expressions of optimism, it is little to be wondered at, therefore, that the convention was a success. There were over 4500 registered. Atlantic City, the dean of America's convention cities, threw open its portals in welcome Monday morning, and throughout the week catered to the comfort and enjoyment of the visiting members and guests.

The convention headquarters were on the Million Dollar Pier, where was also staged the electrical exhibits. The latter was by far the most complete ever staged and extended from the main reception hall almost to the end of the pier. There were over one hundred exhibitors and almost every conceivable kind of electrical apparatus and supplies were on display.

Among the numerous committee reports of the various sections of the association, the one which was of particular importance to engineers in general was that of the Prime Movers Committee. This, as usual, was voluminous, in this case comprising some 340 pages. The amount of technical and engineering data contained in this report, however, is unequaled in any other publication. Due to the large size of this report and to the limited amount of time which the members had to look through it, discussion was not active. The need of classifying causes of turbine outages was discussed at some length and the subject of powdered fuel was introduced by John Anderson, but there was little or no reaction.

Discussion of the report of the Electrical Apparatus Committee was more vigorous. The more definite basis which has been established for rating oil circuit breakers constituted the principal feature of this report, and provoked active discussion. It finally centered, however, around what constitutes the duty cycle of an oil circuit breaker. In other words, should the duty cycle of a breaker start with the breaker open or closed and should it end with the breaker open or closed? Philip Torchiv raised the question as to why a duty cycle should ever be considered as starting with the breaker open. While no definite agreement was reached, the manufacturers stated that they were willing to rate circuit breakers on any duty cycle upon which the operators will agree, but this cycle should be definite.

The members present at this discussion were fortunate in being able to listen to an address by General George O. Squires, chief signal officer of the United States Army. The subject of General Squires' address was "Wired Wireless." He expressed the belief that broadcasting through the lamp socket by means of wired wireless or carrier current, using the power distribution lines as the carriers should meet with universal public favor.

Perhaps the most interesting feature of the entire week was the meeting held on Thursday evening when

the audience was addressed by speakers on the Pacific Coast over the transcontinental telephone line. The entire transcontinental telephone was turned over to the convention, and by means of amplifiers and loud speakers everyone present was able to hear distinctly the voices of the speakers at San Francisco. There are 14 repeater stations in the line between Atlantic City and San Francisco, and in setting up the connections, Bancroft Girardi, vice-president of the American Telephone and Telegraph Company, put on a transcontinental roll call. As each of the repeater stations was called, the wire chief on duty at such stations answered. At the same time the location of the repeater stations was flashed in electric light on a large map of the United States set up at the rear of the stage.

The whole demonstration was carried out without the slightest hitch. The time of setting up the line and calling the roll occupied, perhaps, one minute and when San Francisco was reached, all who were assembled in the theater on the pier stretching out into the Atlantic, heard the voices of speakers standing virtually on the shore of the Pacific, with the same clearness and loudness as those of the speakers in the room.

The national executive officers for the coming year were elected on Friday, immediately preceding the adjournment of the convention.

They are as follows: President, Frank W. Smith, New York, N. Y.; vice-presidents—Walter H. Johnson, Philadelphia, Pa., Franklin T. Griffith, Portland, Ore., J. E. Davidson, Omaha, Neb., R. F. Pack, Minneapolis, Minn.; treasurer, Walter Neumuller, New York, N. Y.; members of the executive committee—T. A. Keeney, Jackson, Mich., Preston Arkwright, Atlanta, Ga., H. C. Abell, New York, N. Y., W. E. Robertson, Buffalo, N. Y., James R. Strong, New York, N. Y., E. M. Herr, Pittsburgh, Pa.; chairman, R. F. Schuchardt, Chicago; vice-chairmen—H. P. Liversidge, Philadelphia, Pa., L. M. Klauber, San Diego, Cal., C. F. Hershfeld, Detroit, Mich.; members at large of executive committee—N. A. Carle, Newark, N. J., I. E. Moultrop, Boston, Mass., Norman Reed, Denver, Col., Nicholas Stahl, Providence, R. I., S. J. Lisberger, San Francisco, Cal.

News Notes

At the annual business meeeting of the American Institute of Electrical Engineers, held in New York, May 19, the following officers were elected for the administrative year beginning Aug. 1, 1922: President, F. B. Jewett, New York; Vice-Presidents: District No. 1, G. Faccioli, Pittsfield, Mass.; District No. 3, W. I. Slichter, New York; District No. 5, R. F. Schuchardt, Chicago; District No. 7, H. W. Eales, St. Louis (re-elected); District No. 9, H. T. Plumb, Salt Lake City, Utah; Managers: H. M. Hobart, Schenectady, N. Y.; Ernest Lunn, Chicago; G. L. Knight, Brooklyn, N. Y.; Treasurer: George A. Hamilton, Elizabeth, N. J. (re-elected).

The above, together with the following hold-over officers, will constitute the board of directors for the next administrative year: William McClellan, New York; A. W. Berresford, Milwaukee; N. W. Storer, Pittsburgh; C. G. Adsit, Atlanta; F. W. Springer, Minneapolis; Robert Sibley, San Francisco; F. R. Ewart, Toronto; L. E. Imlay, Niagara Falls; F. F. Fowle, Chicago; L. F. Morehouse, New York; Harold B. Smith, Worcester, Mass.; James F. Lincoln, Cleveland; E. B. Craft, New York; R. B. Williamson, Milwaukee; A. G. Pierce, Pittsburgh; Harlan A. Pratt, New York.

At the meeting of the board of directors held on the same date, F. L. Hutchinson was re-elected secretary of the Institute for the coming administrative year.

The Eighth National Exposition of Chemical Industries will be held this year in the Grand Central Palace, New York City, during the week Sept. 11-16 inclusive. "Raw Materials, Machinery, Products," is the way the exposition is described and is intended to carry this main impression. The raw materials are exhibits of the natural resources. The machinery exhibits consist of apparatus and equipment and instruments for control, precision, recording, gaging, measuring, and machinery for every mechanical operation in the manufacture of products from the raw materials. The products themselves are the finished products and the exhibits will contain those of organic, and inorganic origin, of solid, liquid, or gaseous form, and of every conceivable nature.

The National Research Council has elected the following chairmen of its divisions for the year 1922-23: Division of Foreign Relations, Robert A. Millikan, Pasadena, Calif.; Division of Educational Relations, Vernon Kellogg, Washington, D. C.; Division of Research Extension, W. M. Corse, Bayonne, N. J.; Research Information Service, Robert M. Yerkes, Washington, D. C.; Division of Physical Sciences, William Duane, Boston, Mass.; Division of Engineering, Alfred D. Flinn, New York, N. Y.; Division of Chemistry and Chemical Technology, Edward W. Washburn, Urbana, Ill.; Division of Geology and Geography, Nevin M. Fenneman, Cincinnati, O.; Division of Medical Sciences, Frederick P. Gay, Berkeley, Calif.; Division of Biology and Agriculture, F. R. Lillie, Chicago, Ill.; Division of Anthropology and Psychology, Raymond Dodge, Middletown, O.

Buell, Scheib, Mueller, Inc., is the firm name of a company recently formed by W. C. Buell, Jr., Walter H. Scheib and Edward O. Mueller for the practice of consulting engineering, making a specialty of problems in construction. Offices are established in the Columbia Bank Building, Pittsburgh, Pa.

Since 1887 Johns-Manville, Inc., has acted as exclusive selling agents for the various products manufactured by the Johns-Pratt Co., of Hartford, Conn. Owing to changing business conditions in the electrical trade, these companies have mutually decided to manufacture and market their respective products separately, this change becoming effective on June 15.

Workmen in Jenkins Bros. Bridgeport, Conn., plant, on the resumption of its full time schedule, were given the option of putting in 48 hr. work in the regulation six days, or of doing the same amount of work in five days, giving them all day Saturday. The men voted for the latter and now, without any loss to them, they have two days in each week for recreation—Saturday and Sunday.

C. O. Sandstrom, W. W. Wheeler and R. C. Clark have opened offices in the Interstate Building, Kansas City, Mo., and will engage in the practice of engineer-

ing and construction under the name of Industrial Service Co.

SPITE of the extremely adverse conditions of the past year, sales of the Westinghouse Electric & Manufacturing Co. amounted to almost exactly $100,000,000, as shown by its annual report, as of March 31, 1922, which is the largest volume of business handled by this company except during the abnormally active previous three years. Manufacturing costs were high, however, as these could not be reduced as rapidly as prices fell. Furthermore, the expense of development work and about $1,500,000 for depreciation of inventory were charged off, so that the increase in surplus was only slightly greater than the amount paid out in dividends.

The excellent "cash position" of the company is shown by the fact that its current assets—including cash, U. S. securities, and accounts and notes receivable—total $41,735,000, while its current liabilities—accounts payable, dividends unpaid, and accrued interest, etc.—are only $11,400,000 and, in addition, the company possesses an inventory of $55,000,000.

Chairman Guy E. Tripp states in his report: "The contraction in orders booked continued throughout the year 1921, but in January, 1922, a substantial improvement began which has since been maintained."

FOLLOWING a meeting of the board of directors of the General Electric Co., held in New York, May 16, C. A. Coffin retired as chairman and was succeeded by Owen D. Young, long associated with the company as vice-president. The position of president was filled by the election of Gerard Swope, president of the International General Electric Co., succeeding E. W. Rice, Jr., who requested to be allowed to devote his entire energies to the further upbuilding of the scientific engineering and technical phases of the company's work in the broadest sense, and who will become honorary chairman of the board of directors. Anson W. Burchard, for many years identified with the company as vice-president, with particular reference to public utilities and foreign investment, was elected vice-chairman of the board. J. R. Lovejoy, vice-president in charge of sales, was elected a director, as was also G. F. Morrison, vice-president.

Mr. Coffin, the retired chairman of the board, will continue as a director to give attention to the problems of the company. He has been for 40 yr. a leading influence in the development of the corporation and was founder and creator of the company and its predecessor the Thomson-Houston Co.

Mr. Young, the new chairman of the board, is a lawyer by profession. In addition to his interest in the General Electric Co. he is chairman of the board of directors of the Radio Corporation of America, director of the Electric Bond and Share Corporation, Bankers Trust Co., and many other organizations.

Mr. Swope, the new president, has both an engineering and commercial training. He was graduated from the Massachusetts Institute of Technology in 1895. That fall he entered the employ of the Western Electric Co. Starting from the bottom in the shops at Chicago, where he was first assigned, he worked his way up, department by department, to an executive position. His first promotion was to the power apparatus engineering department as designing engineer. Next he organized and was first manager of the company's St. Louis house, opened in 1901. Four years later he was called back to Chicago and made manager of the power apparatus department. When in 1908 the company went out of the power apparatus field, Mr. Swope was transferred to New York as general sales manager, and in 1913 he was elected vice-president. This connection he severed Jan. 1, 1919, to become president of the International General Electric Co.

U. S. CIVIL SERVICE COMMISSION announces examinations, July 5 and Aug. 23, for Junior Engineer, Bureau of Standards, to fill vacancies in the Bureau of Standards, Department of Commerce, for duty in Washington, D. C., or elsewhere, at $1200 to $1500 a year, and in positions requiring similar qualifications, at these or higher or lower salaries. Appointees whose services are satisfactory may be allowed the increase granted by Congress of $20 a month. Competitors will be rated on general physics, mathematics through calculus, practical questions on an optional subject from a given list, education, training, and experienee. Applicants must not have reached their fifty-fifth birthday, on the date of examination. This age limit does not apply to persons entitled to preference because of military or naval service. Apply for Form 1312, stating the examination title.

Book Reviews

RICHTER'S ORGANIC CHEMISTRY, VOL. II, CARBOCYCLIC SERIES, translated from the German by E. E. Fournier D'Albe; size 6 by 8½ in., 760 pages, cloth; Philadelphia, 1922.

The eleventh edition of this work, of which this is a translation, was prepared by Richard Anschutz, in collaboration with Dr. Hans Meerwein, assistant instructor in organic chemistry at the Chemical Institute.

The treatment of the general subject of carbocyclic compounds is largely confined to the Hexacarbocyclic groups, the other compounds, mono-, tri-, tetra-, to octo-, being lumped together and discussed but briefly.

The Hex-series are divided into benzene derivatives, hydro-benzol derivatives, and aromatic hydrocarbons and are taken up at length through numerous other divisions and subdivisions.

MECHANICAL STOKERS by Joseph G. Worker and Thomas A. Peebles; size 6 by 9 in., 258 pages, cloth; New York, 1922.

Up to the time of this present publication, few, if any, books on mechanical stokers have been available for the student of combustion engineering. Chapters on this subject have been included in books on boilers, furnaces, and power plant equipment, operation, and maintenance; but in all of these the stoker has been considered more or less in the light of its relation to other items. Few have treated the stoker as an entity.

This book treats combustion as it applies specifically to the burning of coal on a stoker. It takes up in detail descriptions of various types of stokers now being used, their applications and factors governing their selection to meet different conditions with various fuels.

An idea of the scope of the work may be obtained by reviewing the chapter headings. The first chapter is concerned with principles of combustion chemistry. The

second is a history of stoker development from Watt's first furnace. After this there are two sections on coal, coal producing regions, classification, utilization, characteristics and selection of suitable grates for burning. The question of draft is discussed at length in the next section and after that the factors affecting the selection of stoker equipment. "Stoker burning equipment in modern steam power stations" is the heading of the next chapter in which the stokers in several up-to-date plants are described and the reasons for the selection given. The last two chapters constitute a discussion on application, determination of size, installation, specifications, contracts, and results that may be expected.

The question of the selection of a suitable stoker for a given installation is one that merits careful thinking and planning, probably a great deal more than it has been given in the past by the majority of users. A careful study of the facts presented here will enable the reader to look at this question in a more comprehensive manner and to make a more intelligent selection for his particular purpose.

THE DEMAND for quiet rooms and the necessity for solving other problems for the control of noise have led to repeated requests from architects and builders for reliable information on effective methods for insulating sound. Although present information on the subject is incomplete, Bulletin No. 127 of the Engineering Experiment Station of the University of Illinois, "Sound-Proof Partitions," by F. R. Watson, collects and presents the available information in a systematic way, giving the methods and results of various investigations relating to the action of materials on sound, describing practical installations of soundproofing, and setting forth in accordance with existing knowledge recommendations that may be applied where sound insulation is wanted.

Catalog Notes

THE GRISCOM-RUSSELL CO., New York, has just issued Bulletin 904 on the multiwhirl cooler, a shell and tube type cooler, the principal feature of which is a continuous helical baffle from one end of the shell to the other. This apparatus is designed to accomplish a heat exchange between any two liquids, the condensing of vapors, or any similar service.

ALLIS-CHALMERS MANUFACTURING CO.'s new bulletin No. 1109 covers distribution transformers having ratings of 200 kv.a. and smaller suitable for lighting and power purposes of the oil immersed self-cooled outdoor type.

Bulletin No. 1099-B is a revised bulletin covering the company's line of small alternating current generators for belt drive and also for direct coupling.

UEHLING Bulletin 113, just published—Preparing Flue Gas for Analysis, illustrates and explains the "Pyro-porus" gas filter for completely excluding soot and dirt from the gas sampling lines.

KINGSBURY THRUST BEARINGS, Catalog C, recently issued by the Kingsbury Machine Works, Philadelphia, describes in some detail the operation of this type of bearing as used for various purposes. Numerous illustrations are included in the text, showing the different constructions employed on a number of different types of installations.

AN ILLUSTRATED FOLDER from the Turner Brass Works, Sycamore, Ill., describes improvements in the "Turner Master Line" of blow torches.

A BULLETIN recently received from the Sprague Electric Works of the General Electric Co. describes Sprague Narrow-unit Panelboards of the safety type.

FROM Roller-Smith Co., New York, we have received bulletins as follows: Bulletin No. 560, discussing two types of enclosed circuit breakers; Bulletin No. 820, on P V ammeters and voltmeters and C O D indicators.

LONDON STEAM TURBINE CO., Troy, N. Y., has just issued a 28-page bulletin, No. 14, describing single-stage steam turbines of the one bearing type and outlining the advantages of the London steam turbine.

BULLETIN 131 of Taber Pump Co., Buffalo, N. Y., contains hints on the application of rotary pumps, which are of particular interest to the oil industry for unloading or loading tank cars of kerosene, gasoline, oils, etc. A friction table and conversion scale are also included.

BULLETINS NOS. 102 and 103 issued by the Ideal Electric and Manufacturing Co. describe their direct and alternating current motors respectively. In addition to the general descriptive matter, there is given much valuable information regarding the selection of motor equipment.

GRINDLE FUEL EQUIPMENT CO. is sending out its first general catalog on Grindle Powdered Fuel Equipment. This catalog contains 40 pages of text and illustrations, discussing the advantages of powdered fuel in general, and the special advantages and operation of the Grindle System in particular.

THE AMERICAN BOILER TUBE THIMBLE CO., Providence, R. I., has recently issued a folder describing a thimble that is intended to protect the ends of tubes, on fire tube boilers, from the direct heat of the furnace. A curved flange covers the beaded end of the tube and makes a snug fit against the tube sheet.

TYPE E, CIRCULATING OIL FILTRATION SYSTEM, Bulletin 6600, recently received from the Wayne Tank & Pump Co., Fort Wayne, Ind., describes the construction and operation of this filter. Five major treatments are given the oil. It is screened through fine mesh wire cloth, heated, passed over precipitating pans and then through filter bags where the remaining impurities are filtered out.

A THOROUGHLY VENTED renewable fuse, recently developed is discussed and illustrated in Folder 4472, entitled "Shurvent Protection," which has just been published by the Westinghouse Electric & Manufacturing Company. The folder explains the application and design of fuses for the protection of low-voltage circuits up to 600 v. for both alternating-current and direct-current.

BABBITING MOTOR bearings is described in detail in Circular Reprint No. 104, published by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. The publication is a discussion of the production of babbit metal by J. S. Dean, and it contains a number of photographs of equipment used in the manufacture of babbit metals as well as the results of various tests of samples of alloys.